DOMINION OF CANADA

REPORT

OF

THE AIR BOARD

FOR THE

YEAR 1922

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
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INTRODUCTION

On January 1, 1923, the proclamation bringing into effect the Act creating the Department of National Defence was issued. The Air Board ceased to exist as a separate department of the Government on that date. Its functions under this Act are assumed by the Minister of National Defence. Opportunity is therefore taken to review briefly the progress of aeronautics in Canada up to the end of the year 1922, since the formation of the Air Board.

The Air Board Act was assented to on the 6th of June, 1919, and by Order in Council dated the 23rd of June (P.C. 1295) the Honourable A. L. Sifton was named as Chairman of the Board; Colonel O. M. Biggar, Judge Advocate General, Vice-Chairman; the Honourable S. C. Mewburn, Minister of Militia and Defence, representative of the Department of Militia and Defence; the Honourable C. C. Ballantyne, Minister of the Naval Service, representative of the Department of the Naval Service; and Dr. R. M. Coulter, C.M.G., Deputy Postmaster General, Mr. J. A. Wilson, Assistant Deputy Minister, Department of the Naval Service, and Mr. E. S. Busby, Chief Inspector, Department of Customs and Inland Revenue, as the other members of the Board.

The work of forming an organization for the control of commercial aviation, the conduct of civil flying and the administration of the Canadian Air Force was immediately undertaken. Canada was fortunate in having at its dsiposal a large number of experienced flying officers who had served during the war and steps were taken to form a staff from the excellent material available.

Aircraft and equipment to the value of about $5,000,000 had been presented to the Dominion by the Imperial Government after the Armistice. A number of flying boats used by the Royal Canadian Naval Air Force during the war were also available. Active operations could, therefore, be undertaken without the necessity for the purchase of large quantities of material. Stations had been built during the war at Halifax and Sydney, N.S., by the Department of the Naval Service, and at Camp Borden, Ontario, by the Imperial Government. Camp Borden had been transferred later to the Department of Militia and Defence. It was handed over by that department to the Air Board and became the main base of operations.

Aeronautics in Canada has three distinct phases—

(*a*) the control of commercial flying;
(*b*) the conduct of flying for the civil services of the Government;
(*c*) the organization of the air defence of Canada.

The work of the Board was accordingly divided into three main branches with the usual departmental services such as records, correspondence, contracts, supplies and accounting, common to all and serving each.

Canada is a contracting state to the International Convention on Air Navigation. This Convention was drawn up by a Sub-Committee of the Peace Conference in Paris. Under it the contracting states agreed to enact uniform regulations for the conduct of flying, the registration and marking of aircraft and the licensing of pilots, air engineers and navigators. To comply with the terms of the Convention, the Air Regulations, Canada, 1920, were drawn up and approved by Order in Council dated January 17, 1920.

It was realized that aircraft could play a useful and important part in the development of the remoter parts of the country where the available means of transportation are slow, uncertain and laborious. The forest areas also pre-

sented an immediate outlet for flying in connection with their conservation and development by improved methods of fire detection and prevention, and the survey of the large areas of forest still unexplored. In November, 1919, steps were taken to make a preliminary survey of the country with a view to ascertaining what public services could more efficiently and, in the broadest sense, more economically be performed by air than by existing methods. The results were available early in January, 1920, and an Inter-departmental Conference was held for their consideration by the various Government Services interested in forestry, and the exploration and survey of the remoter parts of the country. A programme of operations was adopted at this conference which would give typical experimental operations, on the results of which further work would depend.

The formation of an Air Defence Force received careful consideration. On February 18, 1920, Order in Council No. 395 was approved. This Order in Council, after reviewing the general situation in regard to military aeronautics, points out that war strength in the air must ultimately depend on civil or commercial aviation. It provides for the formation of a non-permanent force, recruited, in the first instance, from those officers and men who had served in the flying services during the war. Provision was made for the administration of the Canadian Air Force through provincial associations. These were made responsible for the local administration and mobilization of the Air Force under the direction of the Air Board. The Lieutenant-Governors of the provinces consented to act as honorary presidents of their associations. Of the remaining members of the executives, three were nominated by the Lieutenant-Governors and four elected by the membrs of the Air Force resident in each province.

The preliminary work of organization having been completed, the Board was reorganized by Order in Council No. 826, dated April 19, 1920, under the chairmanship of the Honourable Hugh Guthrie. Colonel O. M. Biggar was reappointed Vice-Chairman and the heads of the flying and administrative services of the Board (Air Vice-Marshall Sir W. Gwatkin, Inspector-General of the Canadian Air Force; Lt.-Col. R. Leckie, Director of Flying Operations; and Lt.-Col. J. S. Scott, Controller of Civil Aviation) were made members. Capt. W. Hose, Director of the Naval Service, and Dr. E. Deville, Surveyor General of Canada, were appointed to the remaining vacancies, and Mr. J. A. Wilson Secretary of the Board.

The Air Board Estimates 1920-21, providing funds for the control of commercial aviation, the conduct of civil flying operations and Air Force training were passed by Parliament early in July, 1920. The sum made available was $2,250,000.

Under the Air Regulations, 1920, a system for the registration and inspection of all aircraft and the examination and licensing of all pilots, navigators and engineers, had been created in accordance with the terms of the International Convention for Air Navigation. Inspectors were appointed through the Civil Service Commission to ensure the compliance with the regulations on the part of all companies and persons operating aircraft in the Dominion.

An order was passed by the Board regulating inter-state flying between Canada and the United States pending the negotiation of a more permanent agreement. This enabled aircraft and pilots of United States nationality to enter and fly in the country provided the conditions of the Order in Council were observed.

To carry out the recommendations for operations of the Inter-departmental Conference on Civil Operations, work was immediately started to establish stations at Vancouver, B.C., Morley, Alta., and Roberval, P.Q. In addition to this a small unit was formed at Ottawa for the conduct of experimental work in

connection with aerial photography, wireless and other necessary work. Halifax station was provided for as a winter base for machines operating in Eastern Canada. Forest fire prevention and survey was the main purpose of the work at Vancouver, Morley and Roberval, and the Provincial Governments of British Columbia and Quebec made grants towards the establishment and maintenance of the stations in their provinces in return for services rendered to the Provincial Forestry Services.

Steps were taken to prepare Camp Borden for the accommodation and training of the officers and men of the Canadian Air Force. A large number of those who had served in the Air Services during the war volunteered for service and the camp was opened for training on October 1, 1920. The administrative and instructional staff was chosen from those who had special qualifications and training for the positions to be filled. These served normally for periods of from six months to a year and in exceptional cases for longer. The usual course of training was twenty-eight days. This was extended in special cases to three months. Refresher courses were provided for in flying, engine and aircraft construction, repair and maintenance; wireless; aerial photography; meteorology; administrative, equipment and stores duties, and other necessary work.

On the suggestion of the Air Board, the Honorary Advisory Council for Scientific and Industrial Research formed, in 1920, an Associate Air Research Committee to oversee and direct a programme of research on aeronautics in Canada, so that conditions peculiar to flying in this country might be investigated and the interest of the universities and other scientific bodies secured for the development of flying.

The co-operation of the Director of the Meteorological Service for the extension of meteorological work to meet the needs of the Air Board was obtained and observations are carried out at all Stations under his direction.

A Departmental Committee had been formed in 1919, in the Department of Interior, for the consideration of the problems of aerial photographic survey in Canada. Practical tests and investigations were undertaken under the direction of the Surveyor General, who was chairman of this committee and also a member of the Air Board. Arrangements were also made for the conduct of such wireless services as were necessary with the Radio Telegraph Branch, Department of the Naval Service, and later with the Royal Canadian Corps of Signals.

In January, 1921, a second Inter-Departmental Conference was held for the consideration of air operations. As a result of this Conference a more extensive programme of operations was decided on for the summer season of 1921. The work at Vancouver, Roberval, Ottawa and Halifax was continued. In addition a new base was established at Victoria Beach at the request of the Forestry Branch, Department of the Interior, for the patrol of the forest areas surrounding lakes Winnipeg and Winnipegosis. At the request of the Government of Ontario, a mobile unit was established on the National Transcontinental Railway between Sioux Lookout and the Ontario-Manitoba boundary, for the survey and exploration of the forest country lying north of the Transcontinental railway for a distance of 200 miles east of the boundary. The station at Morley was moved to High River, Alta., a more favourable location. Morley was unsuitable as a base because of the immediate proximity of the mountains and the rough nature of the terrain.

C.A.F. training was continued and extended in 1921 at Camp Borden and combined operations with the land and naval forces of the Dominion were undertaken there, at Petawawa, at Sarcee Camp and at Halifax during the training season.

The estimates for the financial year 1921-22 totalled $1,625,000 for Air Services.

Turning to commercial aviation, the progress made between the Armistice and the end of 1921 has been disappointing to those who looked for immediate changes in methods of transportation owing to the development of aircraft during the war. After the Armistice machines were cheap, pilots enthusiastic about flying and the public generally interested in the new form of transportation. Many companies sprang up throughout the country. Their chief business was "joy-riding." Once the first interest and curiosity were satisfied, there was little demand for this form of flying and a number of companies ceased operations. Steady progress has been made, however, in the development of those forms of flying which are of practical use and will prove to be of permanent value to the community. A number of the larger pulp and paper companies are using aircraft in connection with their forestry operations for fire prevention, forest surveying and transportation within their limits. The use of aircraft offers obvious advantages to firms operating over large areas where communications are at present uncertain, slow and laborious. It is in this direction that the immediate development of commercial aviation may be expected in the Dominion, rather than in the operation of express, mail or passenger routes. The difficulty of operating such services is very great in a country where large centres of population are few and, in many instances, separated by wide tracts of unsettled territory. Development along these lines can best be undertaken in Europe and the United States where the traffic is heavier, the demand for express services greater and the communities better able to bear the cost. When air mail, express and passenger services are successful in countries where the climate and natural conditions present less difficulty, they will follow naturally in Canada.

The close of the year 1921 saw the end of the period of preliminary organization and experiment in Canadian aviation. Though much remained to be done both in organization and experiment, yet the foundation was laid and the organization created to ensure steady progress along sound lines in all three phases of aviation.

Canada has led the way in regard to the regulation of air traffic. This country was the first to enact a complete set of Air Regulations covering the whole question. The Air Regulations, Canada, 1920, have proved satisfactory in practice, though experience shows the need of amendment in certain details. The progress made in commercial aviation was small, but it was a sound development and self-supporting. It was a natural growth along useful lines and not artificial or forced into non-economic channels by state aid or subventions. By the foresight and initiative of a small number of men interested in commercial aviation sound foundations for aerial transportation and an aircraft industry in Canada were being quietly laid.

In the Government service the usefulness of aircraft had been proved beyond question as a great aid in forest protection and transportation in unsettled regions, and in survey work. The Canadian Air Force had been established and a beginning made on a small scale to train Canadians in Air Force duties to take their share in the defence of the country in time of emergency with the land and naval forces of the Dominion.

II. DEPARTMENT OF NATIONAL DEFENCE

The Government early in 1922 decided on a policy of centralization in regard to the defence services of the Dominion.

It was felt that, apart from the economies which could certainly be effected by the combining of the functions common to all three departments such as purchasing, contracts, records and correspondence, accounting, engineering services and civil administration, greater efficiency in all three services would result through their being brought into closer touch. Administration by a Minister of the Crown and the heads of the different services working together on a Defence Council, would enable the Minister and, through him the Cabinet, to consider the defence of Canada, and the best means of obtaining full value from the expenditure voted by Parliament for this purpose, as a whole and not as three separate questions. It would ensure the preparation of a comprehensive scheme of defence, covering all phases of the question, by a general Defence Staff representing all three services, rather than three separate programmes, each dealing with one phase of the question only. It would further facilitate the organization and training of the defence personnel to act in co-operation, each arm with the others, so that in time of emergency there would be complete co-operation between the services. Each would then fill its predetermined role with knowledge and understanding of the work of the others. The combination would prevent overlapping and save the waste of effort inevitable under the old system of complete separation of the services.

A Bill creating a Department of National Defence was introduced in the House of Commons by the Hon. G. P. Graham, Minister of Militia and Defence and Chairman of the Air Board, on March 24. It provides for the incorporation of the Departments of Militia and Defence, Naval Service and the Air Board in the new department and charges the Minister of National Defence "with all matters relating to defence, including the Militia, the Military, Naval and Air Services of Canada." It repeals section 2 of the Air Board Act (Statutes of 1919, Chap. 11) dealing with the appointment of the Air Board, and, under clause 7, section 2, provides as follows:—

> "The powers, duties and functions vested in the Air Board by the Air Board Act, chapter eleven of the statutes of 1919, or by any order or regulation made thereunder, shall be administered, exercised and performed by or under the direction of the minister."

The Act passed both Houses of Parliament and was assented to by His Excellency the Governor General on June 28. In order to give time for the reorganization of the departments, necessary before the amalgamation could be completed, it was provided that the Act would come into force on a date to be set by proclamation. This date was subsequently set as January 1, 1923.

III. REORGANIZATION

The first step in the reorganization of the Air Service was the consolidation of the Civil Operations Branch with the Canadian Air Force.

Under the Air Board all operations, except those connected with the training of the C.A.F., or combined operations and training with the Military or Naval Forces, had been carried out by this branch. Its personnel were employed as civil servants and appointed by the Civil Service Commission. All Stations, except Camp Borden, the Air Force training base, were under the direction of this branch, as the work was altogether of a civil character, mainly forest pro-

tection, survey work, exploration and transportation. The staff of the Operations Branch were civil servants. All were members of the Canadian Air Force as well and, during their service in that Force, were granted leave from their Civil duties for that purpose. Most of them had taken their C.A.F. training and many had been employed on the semi-permanent administrative and instructional staff.

The Canadian Air Force, had, up to the present been responsible only for Air Force training. The dual system had its disadvantages. This was specially true in regard to Camp Borden where both branches had establishments. The shops and stores were on a civil basis, while the general administration and training were under Air Force discipline and direction. It was also realized that the administrative and instructional duties in the C.A.F. could not be performed to the greatest advantage by a non-permanent staff. Difficulties had been encountered in the attempt to do so.

It was further desired to make a beginning with the establishment of a permanent nucleus for the C.A.F. which would serve as a foundation round which the non-permanent organization throughout the country could be built.

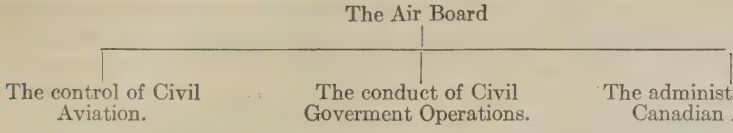
Radical changes in form and the personnel of the organization were therefore necessary.

In September, 1921, Col. O. M. Biggar, K.C., the Vice-Chairman of the Board had tendered his resignation to the Hon. Hugh Guthrie, then Chairman of the Board. He felt that he should not hold any executive position under the Government after his appointment by Parliament to the position of Chief Electoral Officer. This resignation, which had been held in abeyance, both by the late Chairman, the Hon. Hugh Guthrie, and the Hon. G. P. Graham, who succeeded him as Minister of Defence and Chairman of the Air Board, was now accepted. The resignation of Sir W. Gwatkin who had been Inspector General of the Air Force since June, 1920, and who had been acting Vice-Chairman, while Col. Biggar's resignation was pending, was accepted from March 31, 1922. He was granted one year's leave of absence with pay from that date. On these two officers had fallen the burden of the administration of the Department during its formation and to them is largely due the rapid progress made in the successful development of flying in Canada, both civil and military.

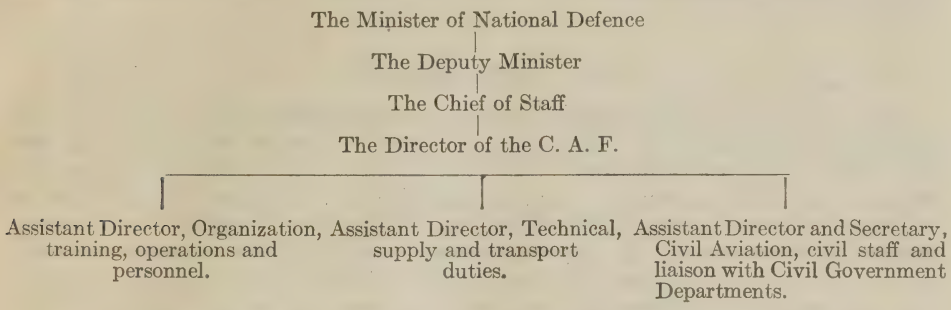
The civil position of Director of Flying Operations was no longer necessary under the new organization. This had been held by Lt.-Col. R. Leckie, D.S.O., D.S.C., D.F.C., a Canadian officer who held a permanent commission in the Royal Air Force and who had been seconded for service with the Canadian Government for a period of three years. This seconding was now terminated and Col. Leckie returned to the R.A.F. for duty. Two other officers in the same position, Capt. J. A. Glen, D.S.C., and Capt. John Barron, were also returned to the R.A.F. The former had served as Superintendent of Equipment in the Operations Branch and the latter as technical adviser to the Board on lighter-than-air duties. As the funds available for aviation would not admit of any work with lighter-than-air machines being undertaken, there was no purpose in retaining his services.

On June 30, an Order in Council was passed approving a temporay organization for the C.A.F. to cover the transition period. This provided for officers and men, now employed as civil servants, being granted temporary commissions, or enlisted, in the C.A.F., and placed the whole organization under the Director of the Canadian Air Force, who was made responsible to the Chief of Staff for the control of aeronautics in all its phases, civil as well as military.

The old system of three directorates, each responsible to the Board for one function of its duties, thus:—



was changed to a single Directorate with the following organizations:—



Wing Commander J. L. Gordon, D.F.C., was apointed Assistant Director, organization, training and operations Branch and Acting Director, C.A.F. He had held the civil position of Superintendent of Flying in the Operations Branch and had recently served a six months' tour of duty in the C.A.F. as Officer Commanding, Camp Borden. His intimate knowledge of both the civil and Air Force duties made this appointment particularly fitting at a time when the amalgamation of the two Branches was in process. The position of Assistant Director, technical, supply and transport, was filled by the appointment of Wing Commander E. W. Stedman, who had held the position of Technical Director under the Air Board. Mr. J. A. Wilson, the Secretary of the Board, was appointed Assistant Director and Secretary of the C.A.F. in charge of the control of civil aviation, the civil staff, estimates, and liaison with other Government Departments.

Wing Commander J. S. Scott, M.C., A.F.C., Controller of Civil Aviation under the Board and who was then serving a tour of duty as Officer Commanding the C.A.F., was placed in command of Camp Borden on July 1 and remained there till October 1, when he proceeded to Kingston to take the preliminary Staff Course at the Royal Military College, preparatory to proceeding overseas to take the Royal Air Force Staff Course at Andover. He was succeeded in the command of Camp Borden by Wing Commander W. G. Barker, V.C., etc.

Wing Commander Scott's place as Controller of Civil Aviation was filled by the appointment of Squadron Leader L. S. Breadner, D.S.C., who had been acting in that capacity during the former's service with the C.A.F.

As the operation season had opened and all Stations were busily engaged on the execution of the programme of flying for other Government Departments, it was decided not to disturb this work by adding the task of reorganization. This was therefore postponed till the end of the flying season in the fall. The changes necessary to bring them into the new scheme were made gradually and as far as possible without disturbing the work of the Stations.

By the end of the year much progress had been made and the new scheme of organization was working both at Headquarters and on all Air Stations. The offices of the Air Force were moved in July from the old premises in the

MacDougal Building, Sussex street, to the Canadian Building, where they were in closer touch with the new departmental organization and the sister services.

The Air Board Records and Contracts branches were incorporated in a common system serving the new department, and progress was made in the amalgamation of the staff dealing with those phases of work common to the three departments. The Accountant's Branch will continue to function as a separate organization till the end of the financial year on March 31, 1923, when the new organization for these important duties in the Department of National Defence will be put into force.

IV. EXPENDITURE

For the financial year 1922-23 the sum of $1,000,000 was voted for aviation, including the Canadian Air Force, flying for other Government departments and the Control of Civil Aviation. This was a reduction of $625,000 from the amount voted in the previous year and necessitated a considerable reduction in the amount of work done. By exercising the greatest economy, it has been possible to maintain all the Air Stations established in the country, although the work at some of them has had to be reduced. At Camp Borden, the refresher courses for officers and men who had seen Air Service during the war were, perforce, stopped. The scheme of cadet training which had been prepared, in conjunction with the universities of Canada, had also to be postponed and many requests for extensions of work from other Government departments had to be refused.

The consolidation of the different branches in the reorganization of the Canadian Air Force, subsequent to the formation of the Department of National Defence, has enabled many economies to be carried out. In addition, the experience gained during previous years showed where economies could be effected in the operations undertaken on the various Stations. By confining expenditure to absolute essentials and reducing the personnel on all units to the lowest limit compatible with safety of operation, it has been possible to carry out a large programme of work for other Government Departments on all Stations, even on the reduced amount available during the year.

Additional revenue amounting to $64,467.06 was available during the year to defray the cost of operations undertaken on repayment for the Provincial Governments of British Columbia, Ontario and Quebec, and also, on account of several small, but important flights undertaken with the approval of the local authorities for commercial firms during the time the forest fire situation was at its worst in British Columbia. These amounts are as follows:—

From ~~British Columbia~~ Quebec	$20,000 00
Ontario	38,909 23
~~Quebec~~ British Columbia	4,824 63
Other sources	733 20
	$64,467 06

V. CIVIL AVIATION

The International Convention for Air Navigation

Canada is a contracting state to this Convention, drawn up by a sub-committee of the Peace Conference in Paris in 1919, for the regulation of air traffic. It provides uniform regulations for the registration and marking of aircraft and their certification for airworthiness; the examination of pilots, navigators and engineers, and their licensing; the rules of the air to be observed

by all aircraft in flight, and many other matters necessary for the safe and proper conduct of international flying. Chapter VIII of the Convention provides for the institution of an International Commission on Air Navigation to be placed under the direction of the League of Nations. The duties of the Commission are defined in the Convention as follows:—

(*a*) To receive proposals from or to make proposals to any of the contracting states for the modification or amendment of the provisions of the present Convention and to notify changes adopted.
(*b*) To carry out the duties imposed upon it by the present Article and by Articles 9, 13, 14, 15, 17, 27, 28, 36 and 37 of the present Convention.
(*c*) To amend the provisions of the Annexes A-G.
(*d*) To collect and communicate to the contracting states information of every kind concerning international air navigation.
(*e*) To collect and communicate to the contracting states all information relating to wireless telegraphy, meteorology, medical science which may be of interest to air navigation.
(*f*) To ensure the publication of maps for air navigation in accordance with the provisions of Annex F.
(*g*) To give its opinion on questions which the states may submit for examination.

Canada as a contracting state is entitled to representation by the appointment of one member of the Commission. The following table gives the contracting States:—

ANNEX A.

STATEMENT AS TO SIGNATURES, RATIFICATIONS, ADHESIONS, DECLARATIONS CONCERNING THE CONVENTION

Designation of States	Convention		Additional Protocol to the Convention Paris, May 1, 1920		Date of Deposit of Ratifications	Date of Adhesion	Declaration concerning the Application of Article 5
	Date of Signature	Date of Accession	Date of Signature	Date of Accession			
United States of America	Oct. 13, 1919		May 1, 1920				
Belgium	" 13, 1919		" 1, 1920		June 1, 1922		June 1, 1922
Bolivia	" 13, 1919		" 1, 1920		" 1, 1922		" 1, 1922
Brazil	" 13, 1919			June 28, 1921			
British Empire	" 13, 1919		May 1, 1920		June 1, 1922		June 1, 1922
China	" 13, 1919		" 1, 1920				
Cuba	" 13, 1919		" 1, 1920				
Ecuador	" 13, 1919		" 1, 1920				
France	" 13, 1919		" 1, 1920		June 1, 1922		June 1, 1922
Greece	" 13, 1919		" 1, 1920		" 1, 1922		" 1, 1922
Haiti							
Honduras							
Hedjaz							
Guatemala	Oct. 13, 1919		May 1, 1920				
Italy	" 13, 1919		" 1, 1920				
Japan	" 13, 1919		" 1, 1920		June 1, 1922		June 10, 1922
Liberia		Mar. 29, 1922		Mar. 29, 1922			
Nicaragua		Dec. 31, 1920		Dec. 31, 1920			
Panama	Oct. 13, 1919		May 1, 1920				
Peru		June 22, 1920		June 22, 1920			
Poland	Oct. 13, 1919		May 1, 1920				
Portugal	" 13, 1919		" 1, 1920		June 1, 1922		June 1, 1922
Roumania	" 13, 1919		" 1, 1920				
The Kingdom of the Serbs, Croats and Slovenes	" 13, 1919		" 1, 1920		June 1, 1922		June 1, 1922
Siam	" 13, 1922		" 1, 1920		" 1, 1922		" 1, 1922
Czecho-Slovakia	" 13, 1919		" 1, 1920				
Uruguay	" 13, 1919		" 1, 1920				
Persia						July 11, 1922	July 25, 1922

International flying in the present stage of aviation is confined, as far as Canada is concerned, to flying between Canada and the United States. Our relations with that country are therefore of the greatest importance. The United States signed the Convention in 1919, but have not yet ratified it. They are therefore not a contracting state and are not represented on the Commission.

The first meeting of the Commission was held in Paris in July, 1922, and the second in London in October. So far Canada has not been directly represented at any of the meetings, but arrangements have been made for the British representative to watch over our interests. It is felt that action should be taken to appoint a direct representative from Canada to the Commission. As the only contracting state from the North American continent, our position is important. Conditions are so different in this continent from those in Europe, that it is essential there should be at least one member of the Commission who is fully acquainted with them and who can present our point of view personally. Pending such an appointment, action has been taken to inform the British representative of the Canadian point of view on the matters coming before the Commission for discussion.

Article V of the Convention, which prohibits the flight over the territory of a contracting state of an aircraft not possessing the nationality of a contracting state, has been made the main subject of discussion in regard to the Convention. Objection was taken to the drastic terms of this Article by practically all signatory states and prior to ratification an additional protocol was added allowing the grant of derogations from the terms of this Article and permitting the postponement of its application pending this.

Action has been taken to apply to the Commission for a derogation from the terms of Article V in respect of flying between Canada and the United States and to postpone its application, pending the grant of such a derogation.

At the second meeting of the Commission, the representative of the French Government proposed an amendment to Article V in the following terms:—

> "No contracting State shall, except by a special and temporary authorization, permit the flight above its territory of an aircraft which does not possess the nationality of a contracting State, unless it has concluded a special convention with the State in which the aircraft is registered. The stipulations of such special convention must not infringe the rights of contracting parties to the present convention and must conform to the rules laid down by the said convention and its annexes. Such special convention shall be communicated to the I.C.A.N., which will bring it to the knowledge of the other contracting States."

This was adopted by the Commission and circulated to the contracting States for their ratification. Unfortunately there has been no convention entered into between Canada and the United States relating to inter-state flying, and until that Government creates an organization for the control of civil aviation, it will be difficult to negotiate one. Canada has, therefore, taken the position that until a derogation* covering flying between the two countries has been granted or the postponement of the application of the original Article and the amendment is assented to, this country cannot ratify the proposal, as it in no way assists our position in regard to inter-state flying between Canada and the United States.

The entry of United States aircraft into Canada is governed at present by an amendment to the Air Regulations, made on June 21, 1920, the effect of which is to place such machines in the same position as if the United States had ratified the Convention, i.e., it gives such machines the right to

*This derogation has now been granted and Canada has concurred in the amendment to Article V proposed by the French Government.

enter and fly in Canada, but not to carry goods or passengers between points in Canada. These regulations have been kept in force at the request of the United States Government pending legislation by Congress in regard to the control of aviation. When this is done and a body is created to control Civil Aviation in the United States, it will be possible to negotiate a convention with that country for international flying. Should they decide to ratify the existing International Convention for Air Navigation, a separate agreement will not be necessary.

VI. COMMERCIAL FLYING

Statistics regarding commercial flying during 1922 will be found on pages 19, 20, 21 and 22. A comparison of this year's figures with those of the two previous years is misleading, in that it does not reveal the real progress made during the year. Notwithstanding the fact that all items recorded are considerably lower than those of 1920 and 1921, it may be said that the year 1922 has been the most successful so far, judging from the results obtained.

The total number of machine flights, machine hours, miles flown, passengers carried, etc., has decreased, it is true, but on the other hand the amount of useful work carried out by aircraft has increased enormously. For instance, in 1921 the total number of hours flown was 4,347, of which 760, or about one-sixth, were on work of a useful character, such as forest fire patrol, forest survey, aerial photography, mail carrying, transportation, etc. The corresponding figure for 1922 was 1,256 hours out of a total of 2,541, or more than half. These figures show that aviation in Canada is progressing steadily and not retrograding, as would appear from a casual comparison of the 1922 summary with those of the previous years.

A map illustrating commercial flying during 1922 is published in this report. It shows, in addition to the location of licensed airharbours and places where commercial flying was undertaken, the areas of fire patrol, areas surveyed and areas photographed in the provinces of Ontario and Quebec during the year. The number of square miles patrolled, surveyed and photographed was 19,678, 19,236 and 791 respectively. This work was carried out by three companies, two of which were operating under contract with the Ontario Government and several of the large pulp and paper companies, and the third, a lumber company, employing aircraft as a subsidiary to their main operations.

It will be seen from the map that one of the areas of fire patrol covers the Haileybury, Cobalt and New Liskeard districts, which were the scenes of that disastrous conflagration last fall. This patrol, unfortunately, was not begun until after the fire, its object being to ascertain the extent of the damage and ensure that the fire was not spreading to other districts. Had aircraft been used to direct the efforts of the fire-fighters at the beginning of the fire, there is no doubt whatever but what it would have been extinguished before reaching such immense proportions.

During the season, 76 forest fires were spotted by commercial aircraft and were promptly put out either by the crews themselves, or reported to a base from which fire-fighters were despatched with the necessary equipment to deal with the emergency. In many cases fire-fighting crews were transported by air to the scene of fires with full fire-fighting apparatus and supplies, thus effecting a considerable saving of time in reaching the scene of the outbreak and preventing the fire from spreading. Thousands of square miles of timber were saved from destruction by this means. Discounting altogether the many other uses to which aircraft can be put in conjunction with fire detection and fire fighting, this is ample justification for the use of aircraft for the preservation of our forests. A report on this subject will be found in Appendix No. 2, page 70.

Another interesting class of pioneer work is being carried out by a British Columbia firm. Operating from their base in Northern British Columbia, this company is contracting for the transportation of men and supplies to mining camps situated in remote parts of the province, to which the canoe, packhorse and dog train were previously the only means of transportation.

During the winter, further work of this nature was carried out by a Montreal firm. Four flights were made by machines fitted with skis, between Cochrane, Ont., on the National Transcontinental railway, and Moose Factory on James bay. The average flying time between these two points was about two and a half hours, as compared with eleven days by dog team in winter and canoe in summer. During the summer the same company, using flying boats of the latest designs, undertook extensive operations in the same district, reaching points as far as Fort Albany and Rupert House on James bay. These operations were successful from all points of view and give promise of a steady field for commercial enterprise.

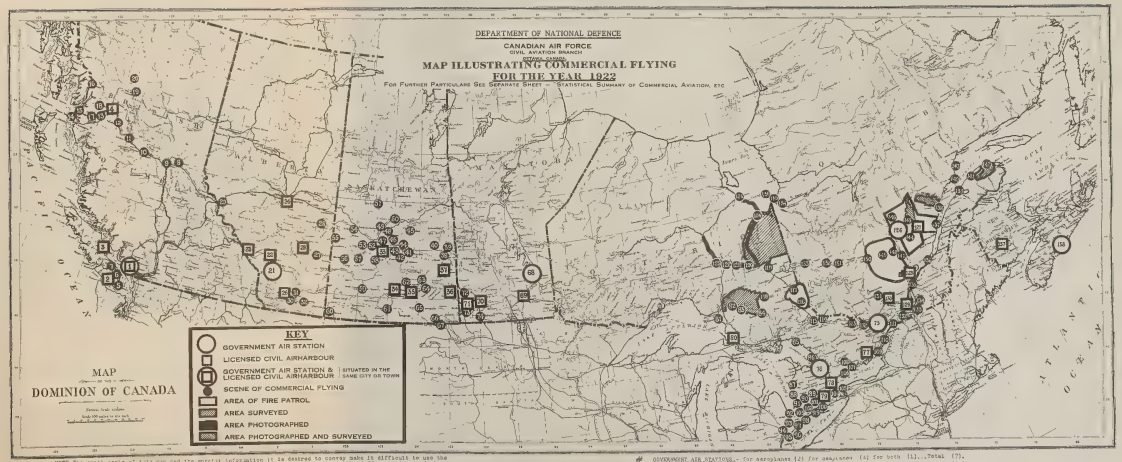
In previous years the only outlet for commercial flying was joy-riding and exhibition. This year, however, saw a marked decrease in this type of work. While this is to be regretted, because such activities have certainly done a great deal to popularize flying, it is the inevitable reaction to the post-war boom. They will probably continue to decrease and will be replaced to an increasing extent by the more useful forms of flying.

The statistical summary shows that 185,211 miles were flown without a single fatal acident. This record is an excellent testimonial to the personnel engaged in commercial aviation and is evidence of the care taken to maintain the machines in an airworthy condition.

Progress as a whole has been satisfactory and there is much to be thankful for considering the many obstacles to be overcome. For the next few years, however, no one should expect very rapid progress on a large scale. The forms of flying which are sound and have proven profitable will be steadily developed and, with improved financial conditions, the necessary capital will become available for the expansion of commercial aviation into many new fields. Such developments take time however and patience is necessary. The work already done is a guarantee of future success provided sound lines are followed. Steady progress on sound lines, even if slow, is infinitely preferable to a rapid expansion ending in a crash through lack of stability.

Those interested in aviation can help the cause best by co-operating in the stimulation of public confidence in aircraft, without which aviation cannot succeed. The success of aviation will be assured just as soon as the public cease to regard flying as a " stunt," and come to look upon it solely as a normal method of transportation having its particular sphere of usefulness just as trains, steamers and motors each have their special fields. Canada has perhaps a larger field where aircraft can be used to advantage than any other civilized country, so that the future should be bright for commercial aviation in the Dominion.

On the map illustrating the areas and places in which commercial flying was undertaken, the large circles indicate the location of government air stations, the smaller squares represent licensed civil airharbours, while the still smaller black dots indicate the places where commercial flying was carried out. A numerical list of all the places referred to on the map by index number follows and a " List of Air Stations and Licensed Airharbours " giving brief particulars of each.



NOTE:-The small scale of this map and the general information it is desired to convey make it difficult to use the regular Airharbour Maritime authorized by Canadian Air Regulations, 1920, to denote the different classes and locations of landing grounds. Care should therefore be taken to read the notes for the special purpose intended and not as though they were authorized Airharbour Maritime.

GOVERNMENT AIR STATIONS.- For aeroplanes (2) for seaplanes (4) for both (1)...Total (7).
‡ LICENSED AIRHARBOURS.-For aeroplanes (2) for seaplanes (8) for both (1)...Total (30).

LIST OF AIRHARBOURS AVAILABLE FOR USE DURING THE YEAR 1922, SHOWING CORRESPONDING REFERENCE NUMBER ON MAP ILLUSTRATING COMMERCIAL FLYING. *See* page 17

Ref. No.	Place	Type of Airharbour	Aeroplanes or Seaplanes	Size	Licensed for Customs
1	Vancouver, B.C.	Government Air Station	Seaplanes	Over 4 miles square	—
"	"	Private-Commercial	"	Approx. 2 miles square	—
2	Esquimalt, B.C.	" "	"	Over 800 yds. square	—
3	Comox, B.C.	" "	"	Over 800 yds. square	—
4	Hazelton, B.C.	" "	Both	200 yds. x 600 yds.	—
21	High River, Alta.	Government Air Station	Aeroplanes	600 yds. x 800 yds.	—
22	Calgary, Alta.	Private-Commercial	"	300 yards square	—
23	Banff, Alta.	" "	Seaplanes	1,000 yds. x 5 miles	—
24	Edmonton, Alta.	" "	Aeroplanes	Under 300 yds. square	—
25	Hanna, Alta.	" "	"	Under 300 yds. square	—
26	Lethbridge, Alta.	" "	"	600 yds. x 800 yds.	—
33	Saskatoon, Sask.	" "	"	400 yds. x 600 yds.	—
"	"	" "	"	300 yds. x 400 yds.	—
34	Moose Jaw, Sask.	Public	"	400 yds. x 700 yds.	Customs.
35	Regina, Sask.	Private-Commercial	"	Over 800 yds. square	—
36	Wapella, Sask.	" "	"	Under 300 yds. square	—
37	Yorkton, Sask.	" "	"	Under 300 yds. square	—
68	Victoria Beach, Man.	Government Air Station	Seaplanes	Over 800 yds. square	—
69	Winnipeg, Man.	Private-Commercial	Aeroplanes	Under 300 yds. square	—
"	"	" "	"	300 yds. x 500 yds.	—
70	Brandon, Man.	" "	"	400 yds. x 600 yds.	—
71	Virden, Man.	Public	"	800 yards square	Customs.
75	Ottawa, Ont.	Government Air Station	Both	400 yds. x 700 yds.	—
				Field under 300 yds. sq.	—
76	Camp Borden, Ont.	" "	Aeroplanes	1 mile x 2 miles	—
77	Deseronto, Ont.	Public	"	400 yds. x 800 yds.	Customs.
78	Toronto, Ont.	"	"	400 yds. in cir. diam.	"
"	"	"	"	400 yds. x 700 yds.	"
79	Brantford, Ont.	Private-Commercial	"	300 yds. x 400 yds.	—
80	Sault Ste. Marie, Ont.	" "	Seaplanes	Over 800 yds. square	—
126	Roberval, P.Q.	Government Air Station	"	Over 800 yds. square	—
127	Chicoutimi, P.Q.	Private-Commercial	"	Over 800 yds. square	—
128	Grand Mere, P.Q.	" "	"	Over 800 yds. square	—
129	Montreal, P.Q.	Public	Aeroplanes	400 yds. x 750 yds.	Customs.
"	"	Private-Commercial	"	Under 300 yds. square	—
130	St. Jovite, P.Q.	" "	"	300 yds. x 500 yds.	—
157	Fredericton, N.B.	Public	Seaplanes	Over 800 yds. square	Customs.
158	Halifax, N.S.	Government Air Station	"	Over 800 yds. square	—

LIST OF PLACES VISITED BY AIRCRAFT OR FLOWN OVER DURING THE YEAR 1922
(Showing Corresponding Reference Number on Map Illustrating Commercial Flying. Page 17)

Ref. No.	Place
	British Columbia—
1	Vancouver
2	Esquimalt
3	Comox
4	Hazelton
5	Victoria
6	Duncans
7	Marigold
8	Dewey
9	Prince George
10	Fort Fraser
11	Decker Lake
12	Smithers
13	Pacific
14	Prince Rupert
15	Port Simpson
16	Stewart
17	Skeena River Valley
18	Nass River Valley
19	Sustut Lake
20	Thudade Lake
	Alberta—
21	High River
22	Calgary
23	Banff
24	Edmonton
25	Hanna
26	Lethbridge
27	Youngstown
28	Wainwright
29	Jasper
30	Stirling
31	Taber
32	Foremost
	Saskatchewan—
33	Saskatoon
34	Moose Jaw
35	Regina
36	Wapella
37	Yorkton
38	Canora
39	Sturgis
40	Kelvington
41	Lanigan
42	Watrous
43	Young
44	Humbolt
45	Melfort
46	Rosthern
47	Warman
48	Laird
49	Carlton
50	Prince Albert
51	Big River
52	Asquith
53	Biggar
54	Battleford

Ref. No.	Place
	Saskatchewan—Con.
55	Macklin
56	Kindersley
57	Rosetown
58	Outlook
59	Swift Current
60	Govenlook
61	Assiniboia
62	Lumsden
63	Qu'Appelle
64	Indian Head
65	Weyburn
66	Estevan
67	Portal
	Manitoba—
68	Victoria Beach
69	Winnipeg
70	Brandon
71	Virden
72	Miniota
73	Oak Lake
74	Boissevain
	Ontario—
75	Ottawa
76	Camp Borden
77	Deseronto
78	Toronto
79	Brantford
80	Sault Ste. Marie
81	Michipicoten
82	Dalton
83	Chapleau
84	Biscotasing
85	Byng Inlet
86	Penetanguishene
87	Southampton
88	Goderich
89	Kitchener
90	Stratford
91	Park Hill
92	Sarnia
93	Dresden
94	Windsor
95	Kingsville
96	Leamington
97	Chatham
98	St. Thomas
99	Tilsonburgh
100	Simcoe
101	Woodstock
102	London
103	Strathroy
104	Hamilton
105	Niagara Falls
106	Bowmanville
107	Cobourg

Ref. No.	Place
	Ontario—Con.
108	Peterborough
109	Kingston
110	Brockville
111	Cornwall
112	Arnprior
113	Pembroke
114	Mattawa
115	North Bay
116	Cobalt
117	Englehart
118	Gladwick
119	Cochrane
120	Lake Remi
121	Mattice
122	Hearst
123	Kabina
124	Moose Factory
125	Fort Albany
	Quebec—
126	Roberval
127	Chicoutimi
128	Grand Mere
129	Montreal
130	St. Jovite
131	Labelle
132	Valleyfield
133	Farnham
134	Granby
135	Three Rivers
136	Quebec
137	Tadousac
138	Laval Bay
139	Matane
140	Pointe des Monts
141	Ste. Anne des Monts
142	Cap Magdalen
143	Lobster Bay
144	St. Jerome
145	St. Gedeon
146	Mistassini
147	La Tuque
148	Cressman
149	Hibbard
150	Parent
151	Doucet
152	Nottaway
153	Authier
154	Rupert House
155	Jacob Island
156	Charlton Island
	New Brunswick—
157	Fredericton
	Nova Scotia—
158	Halifax

STATISTICAL SUMMARY OF CIVIL AVIATION IN CANADA, 1922

*Nature of Information	Commercial	Civil Government	Total Combined
General Analysis			
Firms manufacturing aircraft	1	–	1
Firms chiefly jobbing aircraft	1	–	1
Firms chiefly operating aircraft	23	–	23
Firms using aircraft as auxiliary service	1	–	1
Machine-flights made	4,415	1,437	5,852
Machine-hours flown	2,541	2,793	5,334
Approximate aeroplane-machine mileage	106,353	86,060	192,413
Approximate seaplane-machine mileage	52,420	95,449	147,869
Approximate amphibian mileage	26,438	–	26,438
Total machine-mileage (flying machines)	185,211	181,509	366,720
Average flight duration (hours-minutes)	0–35	1–56	0–55
Number of pilots carried	4,415	1,437	5,852
Number of crew carried	–	1,172	1,172
Number of passengers carried	4,282	856	5,138
Total personnel carried	8,697	3,465	12,162
Pilots carried one mile (pilot-miles)	185,211	181,509	366,720
Crew carried one mile (crew-miles)	–	114,264	114,264
Passengers carried one mile (passenger-miles)	184,928	138,234	323,162
Total personnel carried one mile (personnel-miles)	370,139	434,007	804,146
Total freight or express carried (lbs.)	14,681	–	14,681
Total mail carried (lbs.)	62,025	–	62,025
Licensed Civil Airharbours			
Aerodromes (public)	6	–	6
Aerodromes (private-commercial)	15	1	16
Licensed for Customs	6	–	6
Seaplane stations (public)	1	–	1
Seaplane stations (private-commercial)	7	4	11
Licensed also for Customs	1	–	1
Aerodrome-seaplane stations (public)	–	–	–
Aerodrome-seaplane stations (private-commercial)	1	1	2
Licensed also for Customs	–	–	–
Airship Harbours	–	–	–
Licensed also for Customs	–	–	–
Total airharbours (all types)	30	6	36
Licensed Civil Aircraft			
Aeroplanes (single-engined)	46	6	52
Aeroplanes (twin-engined)	–	–	–
Float seaplanes (single-engined)	5	3	8
Float seaplanes (twin-engined)	1	–	1
Boat seaplanes (single-engined)	7	15	22
Boat seaplanes (twin-engined)	–	5	5
Amphibians (single-engined)	1	–	1
Amphibians (twin-engined)	–	–	–
Airships	–	–	–
Balloons	–	–	–
Total aircraft (all types)	60	29	89
Licensed Civil Air Personnel			
Pilots only (flying machines)	70	11	81
Pilot-Air Engineers	69	12	81
Pilot-Air Navigators	–	–	–
Pilot-Air Engineer-Air Navigators	1	–	1
Air Engineers only (flying machines)	93	34	127
Air Engineer-Air Navigators	–	–	–
Air Navigators only (flying machines)	–	–	–
Airship Officer Pilots (1st Class)	–	1	1
Balloon Pilots	–	–	–
Total licensed personnel	164	46	210
Unlicensed Air Mechanics employed	20	66	86

*As regards Private Flying during 1922, 41 persons have held Private Pilots' Certificates only, and 2 Private Aircraft were registered.

STATISTICAL SUMMARY OF CIVIL AVIATION ACCIDENTS FOR THE YEAR 1922

Nature of Information	Commercial	Civil Government	Total Combined
Analysis of Flying Accidents			
Accidents resulting in death to one or more occupants of machine	Nil	2	2
Accidents resulting only in injury to occupants of machine	3	–	3
Accidents not involving injury to occupants of machine	4	1	5
Total flying accidents	7	3	10
Accidents (included above) resulting in death to third party	1	–	1
Accidents (included above) resulting only in injury to third party	2	–	2
Accidents (included above) not involving injury to third party	4	–	4
Accidents (included above) resulting in death to occupants or third party	1	2	3
Accidents (included above) resulting only in injury to occupants or third party	5	–	5
Accidents (included above) not involving injury to any personnel	1	1	2
Casualties to Personnel			
Pilots killed	Nil	2	2
Pilots injured	3	–	3
Crew killed	*–	–	Nil
Crew injured	*–	1	1
Passengers killed	Nil	1	1
Passengers injured	4	–	4
Third party killed	1	–	1
Third party injured	2	–	2
Total personnel killed	1	3	4
Total personnel injured	6	1	7
Accident and Casualty Rates			
Number of machine-miles per accident	26,459	60,503	36,672
Number of machine-flights per accident	631	479	585
Number of machine-hours per accident	363	931	533
Pilots killed per 1,000 miles flown by pilots	Nil	·0110	·0054
Pilots injured per 1,000 miles flown by pilots	·0162	–	·0081
Crew killed per 1,000 miles flown by crew	*–	–	–
Crew injured per 1,000 miles flown by crew	*–	·0088	·0088
Passengers killed per 1,000 passenger-miles	–	·0055	·0031
Passengers injured per 1,000 passenger-miles	·0216	–	·0124
Passengers killed per 1,000 passengers carried	Nil	1·16	·194
Passengers injured per 1,000 passengers carried	·957	–	·778
Third party killed per 1,000 machine-miles	·0054	–	·0027
Third party injured per 1,000 machine-miles	·0108	–	·0054

Note.—Wherever items are marked thus (– –) in the right hand columns, a "nil" return is signified.
*No crew carried as such.

STATISTICAL SUMMARY OF COMMERCIAL AVIATION (BY PROVINCES) FOR THE YEAR 1922

Province	Number of firms (location of headquarters)	Nature of Operations and Number of Firms Engaged in Each										Machine flights	Machine hours	Average flight duration—hours–minutes	Approximate aeroplane machine mileage	Approximate seaplane machine mileage	Approximate amphibian machine mileage	Total machine mileage (flying machines)	Approximate area of fire patrol (square miles)	Number of square miles surveyed	Number of square miles photographed
		Passenger carrying	Exhibition flying	Air reconnaissance and exploration	Freight or express carrying	Aerial photography generally	Air photographic surveying	Forest reconnaissance and fire protection	Mail carrying	Advertising	Flying instruction										
British Columbia	3	2	–	1	–	1	–	1	1	–	1	1,026	498–35	0–28	1,770	33,562	–	35,332			
Alberta	2	2	1	–	1	1	–	–	1	1	2	101	71	0–42	5,630	–	–	5,630			5
Saskatchewan	4	4	4	–	–	–	–	–	–	3	1	747	284	0–23	18,980	–	–	18,980			
Manitoba	2	1	1	–	–	1	–	–	–	1	1	520	274–30	0–31	19,050	–	–	19,050			
Ontario	10	8	8	3	1	4	3	1	1	6	3	1,413	932	0–39	30,265	19,148	23,089	72,502	2,175	15,236	286
Quebec	4	3	1	2	1	2	2	2	1	1	2	608	482	0–47	6,006	24,362	3,349	33,717	16,500	4,000	500
New Brunswick	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nova Scotia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Prince Edward Island	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Totals	25	20	15	6	3	9	5	4	4	12	10	4,415	2,541	0–35	81,701	77,072	26,438	185,211	18,675	19,236	791

* These figures naturally show considerable duplication in the actual number of firms engaged, since in several instances the same firm is represented at the same time under different kinds of operations and under different provinces.

STATISTICAL SUMMARY OF COMMERCIAL AVIATION (BY PROVINCES) FOR THE YEAR 1922

(For Map Locations *see* separate sheet—"Map Illustrating Commercial Flying, etc.")

Province	Analysis of Transportation					Licensed Air harbours				†Licensed Aircraft				‡Licensed Personnel						†Personnel Employed		
	Passengers carried	Pilots carried one mile (Pilot-Miles)	Passengers carried one mile (Passenger-Miles)	Total personnel carried one mile (Personnel-Miles)	Freight express or mail carried (lbs.)	Public	Private-Commercial	Licensed also for Customs	Total air harbours	Aeroplanes	Float Seaplanes	Boat Seaplanes	Total Aircraft	Pilots only	Pilot-Air Engineers	Pilot-Air Engineers Air Navigators	Air Engineers only	Airship Officer Pilots	Total licensed personnel	Pilots actually employed	Air Engineers actually employed	Unlicensed Air Mechanics actually employed
British Columbia	1,031	35,332	26,039	61,371	*62,000	–	4	–	4	2	4	2	8	4	13	–	12	–	16	3	2	–
Alberta	135	5,630	9,203	14,833	125	–	5	–	5	5	–	1	6	10	15	–	19	–	29	2	2	1
Northwest Territories	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Saskatchewan	610	18,980	16,589	35,569	–	1	4	1	5	10	–	–	10	6	9	–	15	–	21	5	5	2
Manitoba	489	19,050	19,486	38,536	–	1	3	1	4	8	–	–	8	5	11	–	20	–	25	1	1	1
Ontario	1,349	72,502	79,204	151,706	8,581	3	3	3	6	11	1	–	12	33	25	–	39	1	73	11	5	13
Quebec	668	33,717	34,407	68,124	6,000	1	4	1	5	8	1	5	14	18	4	–	17	–	35	8	11	3
New Brunswick	–	–	–	–	–	1	–	1	1	–	–	–	–	1	1	–	2	–	3	–	–	–
Nova Scotia	–	–	–	–	–	–	–	–	–	2	–	–	2	4	4	1	2	–	7	–	–	–
Prince Edward Island	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–
Totals	4,282	185,211	184,928	370,139	76,706	7	23	7	30	46	6	8	60	81	82	1	127	1	210	30	26	20

NOTES.—*Mail service between Seattle, Vancouver and Victoria.
†Allocation by Provinces is governed by location of Headquarters of owner or employer.
‡Allocation by Provinces is governed by home address of individuals.

VII. THE AIRCRAFT INDUSTRY

During the war the urgent necessity for increasing the sources of supply of aircraft for the Allies resulted in a flourishing aircraft industry being established in Canada. Many hundreds of machines were constructed in this country and used for training purposes here. Many more were shipped overseas for active service. After the Armistice lack of a market for aircraft resulted in the closing down of the factories as, prior to the Armistice, nothing had been done to develop civil aviation in Canada. The demand for aircraft for civil purposes is now commencing and, though still small, it will undoubtedly increase as the advantages of aerial transportation become better known.

An aircraft industry is an essential part of any scheme for the defence of the country. Apart from that phase of the question, there is no reason why aircraft cannot profitably be manufactured here. Canada is the greatest source of supply for the spruce which enters so largely into their construction. Metal machines will undoubtedly be produced as the industry develops, yet there is every reason to suppose that for many purposes wood will maintain its place as the best material. It is gratifying to note that during the past year progress has been made in the effort to re-establish the aircraft industry so that the machines flown in Canada may be manufactured here, repairs and alterations may be carried out, and spare parts be obtainable without loss of time. Flying boats will undoubtedly be largely used in Canada. Much work of a similar nature to the construction of flying boat hulls and seaplane floats is now a part of the every day work of many firms throughout the Dominion. It should not be difficult to create the added facilities required to build complete machines at a cost comparable to that at which they are produced in the United States, Great Britain or France. The manufacture of aircraft engines is a matter of much greater difficulty and it will probably be some time before the demand will justify the establishment of special factories for this purpose. This also applies to the instruments and many accessories special to aircraft. These must continue to be imported until the demand is much greater than at present. In regard to the machines themselves, however, the prospects are that within a year or two there may be a sound aircraft industry established in this country to build the machines required not only for the Government but also for commercial aircraft firms.

VIII. CANADIAN AIR FORCE ORGANIZATION AND TRAINING

The year 1922 has been for the Canadian Air Force one of reorganization. During the first quarter of the year the administration of the Force by a semi-permanent staff, appointed for periods of between six months and a year's duty, was continued. Canadian Air Force training consisted in granting, to officers and men who had served in the Air Force during the war, refresher courses in flying and ground duties at Camp Borden for twenty-eight days or three months as the circumstances required.

The large reduction in the appropriation for aviation for the financial year 1922-23 made it impossible to continue training on a large scale and, on the 1st of April, the granting of refresher courses to officers and men who had served during the war ceased for the time being. The administrative and instructional staff at Camp Borden was reduced to meet the new situation. A number of the surplus officers were appointed for duty on the flying operations for other Government departments at the other stations throughout the country.

The changes in personnel and organization necessitated by the new conditions are shown in section 3 of this report and need not be repeated.

On June 29, Order in Council No. 1345 was approved authorizing a temporary establishment for the Canadian Air Force during the re-organization period and pending its establishment as a permanent service. This establishment is as follows:—

—	Flying Officers	Ground Officers	Mechanics	Other Trades	Miscellaneous	Total
Group Captain	1	–	–	–	–	1
Wing Commander	2	1	–	–	–	3
Squadron Leader	7	–	–	–	–	7
Flight Lieutenant	10	6	–	–	–	16
Flying Officer	19	6	–	–	–	25
Pilot Officer	6	11	–	–	–	17
Total Officers	45	24	–	–	–	—69
Warrant Officer	–	–	–	2	–	2
Flight Sergeant	–	–	13	4	–	17
Sergeant	–	–	22	15	–	37
Corporal	–	–	26	12	–	38
Leading Aircraftsman	–	–	16	5	–	21
Aircraftsman 1	–	–	44	32	–	76
Aircraftsman 2	–	–	–	9	38	47
Total other ranks	–	–	121	79	38	—238
Total	45	24	121	79	38	307

Steps were taken to fill the positions in the new establishment by the appointment of officers and men from those serving with the C.A.F. and the Operations Branch. At Headquarters the change was made at once and on the other stations as conditions permitted.

At Camp Borden the Equipment Branch, administered as a civil unit until July, was taken over by the Air Force and the personnel enlisted or granted commissions in the Canadian Air Force. The whole camp, with the exception of the camp maintenance section, is now under Air Force discipline. This change has undoubtedly simplified the administration and enabled reductions to be made in the numbers employed.

During the summer months the camp was used as a training base for a section of the Royal Canadian Corps of Signals and accommodation was found for officers and men of that corps in the Canadian Air Force quarters. Special courses of instruction were held in the fall at Camp Borden in artillery co-operation. At the Royal Military College, Kingston, a special course was arranged for Canadian Air Force officers in administrative duties. Appointments to this course were made from the staff of the Canadian Air Force with a view to qualifying selected officers for the duty of Adjutant on Canadian Air Force Stations throughout Canada. Arrangements have been made whereby an officer from the Canadian Air Force may attend the one-year staff course at the Royal Air Force College near Andover, England. The first officer selected for this important duty was Wing Commander J. S. Scott. He proceeded in October to the Royal Military College, Kingston, for a three months' preliminary staff course there, preparatory to going overseas early in 1923 to attend the Royal Air Force Staff Course at Andover.

While the direction of all work from the date of reorganization in June came under the C.A.F., the change from civil to Air Force administration on the operations branch stations was proceeded with gradually. It was not desired to interrupt the course of the flying operations on the stations during the summer months by a change in the method of administration. All new

appointments made to such stations were made from the Canadian Air Force and, in the fall, when the season's flying was completed, the civil staff were enlisted or granted commissions to complete the reorganization. Any civil employees not desiring to join the Canadian Air Force were granted generous terms of release, allowing them from one to two months' leave with pay, depending on their length of service, in which to find new positions.

In the Manitoba area space was available in the Fort Osborne Barracks at Tuxedo Park and arrangements were made for the accommodation there, on their return from the summer bases, of the staffs employed at Victoria Beach, Norway House and Le Pas, for the carrying out of the necessary overhaul of the machines during the winter. Approval has been obtained for the purchase of land, for aerodrome purposes, adjacent to the barracks. It is the intention to make Winnipeg the headquarters for the C.A.F. in the Prairie Provinces, detaching units during the season of operation, as necessary, to undertake the flying required for other Government departments.

The work of reorganization and the reduction of the estimates has prevented any extensive programme of distinctively military flying being undertaken. At Camp Borden during the year the total flying time was 986 hours. This included training, testing of machines after overhaul, experimental work and an operation for the Geodetic Survey Branch, Department of Interior. This was required to complete the mosaic of the city of London, Ont. A photographic machine was flown from the camp to London in November and after 13 hours 35 minutes' flying, including the journeys out and home, this operation was successfully completed.

At all stations a certain amount of military work has been done for the purposes of the Department of Defence. At Vancouver flights of a duration of 16 hours 26 minutes were undertaken for various purposes, including a mosaic of the Fraser River estuary. From High river, in the beginning of September, aerial artillery observation, for batteries in training at Sarcee camp, near Calgary, was carried out successfully, necessitating 3 hours and 17 minutes' flying. A small amount of photography was done in the Manitoba area, and from Ottawa Station transportation and photographic operations were carried out involving 16 hours and 30 minutes' flying. At Dartmouth, N.S., observation during artillery practise was carried out in conjunction with the Garrison during October. During this test, trials were made of radio-telephony under direction of the Royal Canadian Corps of Signals.

Summaries of Air Force training and flying will be found on page 27.

The question of training a new generation of pilots to take the place of those now flying has received consideration during the year. No new pilots have been trained since the Armistice. While the idea that flying is an occupation for which youth is an essential is no longer so widely held, there is no doubt that the fighting pilot at least should be not over the age of 30. Experience tends to show that pilots in civil aviation can continue their flying almost indefinitely. The great majority of those who served in the war have now taken up other occupations in civil life. They can no longer be counted on as a reserve from which to draw men to meet the increasing demand for pilots for civil aviation, nor can they supply to the best advantage any emergent call for service. It is, therefore, essential that a beginning should be made to train a steady supply of young pilots.

After careful consideration it was decided that the best material for this purpose could be drawn from the engineering and science schools of the Canadian universities. A scheme whereby students in such schools could take a course of training in aviation during the vacations in their college careers

was drawn up. The idea has been submitted to the authorities of Canadian universities and has received a gratifying response from them. They have unanimously agreed to the principle and offered their support in carrying it out. The proposal is, briefly, that a selection be made each year of a number of students, about thirty in the first instance, in the first year of their course in science or engineering and that during their summer vacations for three or four years they should be sent to Camp Borden and there undergo, for a period of three or four months, a thorough training in aeronautics in all its phases, both theoretical and practical. They would pass through the workshops, learning the actual construction of the machines and engines, and be given courses of lectures on all phases of the subject and, in addition, taught how to fly the different types of machines. They would receive in addition to food and quarters, a small rate of pay corresponding to the amount they would probably earn while engaged on survey parties or working in factories as is the custom of such students during the vacations. The experience gained would be invaluable to them in their engineering and scientific course. Even if places could not be found for all such cadets, in the Air Force or in commercial aviation, they would form a reserve from which a supply of pilots could be obtained if necessity arose. The universities would continue the theoretical work during the sessions by giving lectures on aerodynamics and other kindred subjects. There would thus be ensured to aviation a constant stream of the best type of young men, thoroughly trained, not only in flying, but having the splendid background of a thorough scientific education as well.

The reduction of the estimates made it impossible to put the scheme in force during the financial year 1922-23, but it is hoped that during the next season a start may be made, with the co-operation of the university authorities, in training young pilots, so that in a few years' time a new generation may be trained to take the place of those who, from age or any other reason, give up flying.

During the year the closest co-operation has existed between the Air Force and the Royal Canadian Corps of Signals. All wireless work for the Air Force has been undertaken by them and very remarkable results have been obtained in the development of wireless telephone communication between machines and ground stations. At High River continuous communication between machines on patrol and the base has been possible over distances of 175 miles. The efficiency of the forest patrol has been greatly increased by this means. The safety of flying over the foothills is also increased as the pilot is in communication with his base at all times and in case of trouble can report his position exactly. An extension of wireless communication to increase the efficiency of the forestry work and render communication between forest and air headquarters in Winnipeg and their outlying bases and between their bases and machines flying over the farthest reserves in northern Manitoba, was undertaken during the year and satisfactory progress made in its establishment. In an unsettled territory such as this, where distances are very great and communications slow and imperfect, the installation of a system of cheap, reliable and instantaneous communication will be of inestimable benefit. A description of the operations undertaken by the Canadian Air Force for other Government Departments will be found in section IX of this report.

STATISTICAL SUMMARY OF CANADIAN AIR FORCE TRAINING AT CAMP BORDEN, ONT., 1920, 1921 and 1922

Classification	Total 1920 and 1921	1922					Grand Total 1920–21–22
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total 1922	
Completed Training—							
†Officers' Short Course (Flying)	365	48	3	–	–	51	416
" " (Ground)	53	24	–	–	–	24	77
*x*Officers' Long Course (Flying)	26	–	–	–	–	–	26
" " (Ground)	17	9	1	1	3	14	31
Total Officers	461	81	4	1	3	89	550
Airmen's Short Course	758	170	2	1	1	174	932
" Long Course	188	75	44	20	12	151	339
Total Airmen	946	245	46	21	13	325	1,271
Average Strength Return—							
*Long Course (Officers and Airmen)	18/101	16/119	14/90	15/92	18/114	16/103	17/102
‡Short Course " "	28/119	22/99	–	–	–	5/25	20/88
Total in Camp " "	46/220	38/218	14/90	15/92	18/114	21/128	37/190
Flying Time—							
Total flying hours in camp	3,353	854·15	26·30	63·10	42·05	986·00	4,339·00

†Officers' and Airmen's "Short Course" training normally covers a period of 28 days. In certain cases, however, where further instruction is necessary, "Extended" Short Course training is given for an additional period of 2 months or less as required. *x* Officers' and Airmen's "Long Course" training covers a varying period of 3 months or more as circumstances may require. *Includes administrative and instructional staff. ‡The granting of Short Refresher Courses ceased April 1st, 1922.

STATISTICAL SUMMARY OF CANADIAN AIR FORCE FLYING FOR THE YEAR 1922

Station or Place	Aeros or Seaplanes	Flying Period to Date (Days)	Nature of Flights						Total Flights	Total Hours Flown	Approx. Miles Flown	Aver. Flight Duration (Hrs.–Min.)	Days on which Flying took place
			Regular Training	Combined Manoeuvres with other Forces	Photographic Operations	Communication	Special Duties	Miscellaneous					
*Camp Borden, Ont.	A.	365	1,669	39	46	10	–	–	1,764	976:45	63,490	0:33	†140
*Camp Borden, Ont.	S.	8	13	–	–	–	–	–	13	9:15	555	0:42	8
Detached Operations													
Halifax, N.S.	S.	3	–	3	–	–	–		3	3:55	235	1:18	3
Sarcee, Alta.	A.	3	..	4	–	–	–	–	4	3:15	292	0:48	3
Totals		379	1,672	46	46	10	–	–	1,784	993:10	64,572	0:33	154

* Main Training Depot, C.A.F. † No Flying undertaken on Sundays.

Total Aeroplane Mileage, 42,432. Seaplane Machine Mileage, 790.

IX. OPERATIONS FOR OTHER GOVERNMENT DEPARTMENTS

Flying for other Government departments, chiefly the Forest and Survey services has been carried out for the purpose of increasing the efficiency of work undertaken in the remoter parts of the country where communications are at present undeveloped.

Canada is fortunate in possessing much work of importance where aircraft can be employed to advantage. There is no doubt, in the light of the knowledge gained during the past three years, that aviation can play an important part in development of the vast territories lying to the north of our present railroads, by providing a method of transportation and observation, fast, reliable and easy, as an alternative to the canoe, dog and pack train by which these immense distances must be covered under present conditions. The protection of our forest resources from fire; their survey by aerial photography and sketching; the transportation and maintenance of survey parties in the field; mapping from aerial photographs; and other similar work is the most practical line of development for civil aviation in Canada and the one on which the energies of the Air Service are, and have been, directed from the beginning. Thanks to the ready and generous co-operation received from all branches of the Government engaged in work of this nature, much progress has already been made in opening up these new fields for aviation.

After the close of operations in 1921 the question of the preparation of a programme for 1922 was undertaken. The valuable experience gained during the previous summer was most useful as a guide for the preparation of further work. An inter-Departmental Conference was held in January for the discussion of the proposed operations with a view to arranging a schedule of work at each station, satisfactory to each Department and promising the most efficient results from a minimum of expenditure. Representatives from the following branches of the Government service were present:—

Interior Department.

The Surveyor General.
The Dominion Parks Branch.
The Town Planning Branch.
The Natural Resources Intelligence Branch.
The Geodetic Survey Branch.
The Forestry Branch.
The Topographical Survey Branch.
The Dominion Water Powers Branch.
The Reclamation Service.
The International Boundaries Commission.
The Northwest Territories Branch.

Mines Department.

The Deputy Minister.
The Director of Geological Surveys.

Department of Indian Affairs.

The Inspector of Indian Agencies.

Department of Marine and Fisheries.

The Superintendent of Fish Culture.

Department of Agriculture.

The Entomological Branch.

Royal Canadian Mounted Police.

Department of Customs.

Department of Immigration.

As a result of this Conference and subsequent discussions with the heads of each Branch it was possible to lay down in advance the following programme of work for 1922.

INTERIOR DEPARTMENT

Forestry Branch.

A continuation of the fire detection and prevention patrols in British Columbia, Alberta and Manitoba as carried out during 1921. Their extension, if funds permitted, into northern Manitoba and Saskatchewan by the establishment of sub-bases at Norway House, Le Pas and Cowan Lake.

The improvement of the patrols in Alberta by the establishment of sub-bases at Eckville and Pincher Creek so as to enable a wider area to be covered and morning and afternoon patrols made each day while the fire risk was great.

The continuation of aerial photography for the survey of the forest reserves and the study of forest types. Copies of all pictures taken for other branches of the service or Provincial Governments to be made available for the compilation of data on these points.

(A report on the results of the preliminary operations for the Forestry Branch will be found in Appendix No. 2, page 70.)

Goedetic Survey.

A continuation of the transportation of survey parties and their equipment done during 1921, from Vancouver eastward along the Fraser Valley, in connection with the Primary Triangulation Scheme in that territory.

Reconnaissance flights and photography from Jasper along the continental watershed forming the British Columbia-Alberta boundary, north to the junction of the 120th Meridian with the watershed, for the triangulation party working on the British Columbia-Alberta boundary.

If other operations permit, transportation work for survey parties working along the north shore of the St. Lawrence between Clark City and the Straits of Belle Isle.

Topographical Survey Branch.

Vertical photography in the Moose Mountain area, Saskatchewan.

Vertical and oblique photography along the line of the Manitoba-Ontario boundary in connection with the survey of that boundary and transportation work for the survey party marking the line north from the English river.

Transportation for the Controller of Surveys in Manitoba and northern Saskatchewan, while on inspection work in these districts and ærial photography, oblique and vertical, under his direction as required.

Vertical and oblique photography on the courses of the streams flowing east from the Rocky mountains in southern Alberta. (This work to be undertaken in conjunction with similar work for the Reclamation Service and International Joint Commission).

The making of a mosaic of a complete township in the Calgary district for comparison of the results with those of ground surveys.

Reconnaissance flights from Jasper, Alberta, for Mr. A. O. Wheeler, Commissioner for British Columbia on the British Columbia-Alberta boundary commission, to be undertaken in conjunction with similar flights for the Geodetic Survey.

Continuation from the Ottawa Station of experimental work carried out last year in connection with the testing of Prof. H. L. Cooke's camera for aerial surveying.

National Parks Branch.

The extension of the fire patrols now done for the Forestry Branch in southern Alberta into the Waterton Lakes Park.

Photography in the Jasper area of remote parts regarding which little knowledge is now available, to be undertaken in conjunction with the flights over the British Columbia-Alberta boundary.

Examination of flying conditions in the Rocky Mountain Park with a view to extension of the fire patrols in the forest reserves outside the park to cover park areas.

Oblique photography in the valleys of the Gatineau and Lievre rivers in connection with the proposal to form a National Park in that area.

If other operations permit transportation and co-operation with officers of the branch in connection with the protection of migratory birds along the north shore of the St. Lawrence and elsewhere.

Reclamation Service

Photographic reconnaissance of the headwaters of the following streams in Alberta:—

Highwood river, Willow creek, Oldman river, Crowsnest and Castle rivers, Pincher creek, Drywood river, Mosquito creek, Sheep river.

Photographic reconnaissance in connection with the extension of irrigation and drainage schemes along the course of the North Saskatchewan, Clearwater, Red Deer and other rivers in Alberta.

Preparation of a mosaic of the Carrot River triangle, northern Saskatchewan.

Copies of all pictures taken for the International Boundary Commission along the courses of international streams in southern Alberta and Montana.

Water Powers Branch

Photographic survey of Coquitlam Reserve in British Columbia, to determine the portion of the reserve lying in the watershed tributary area and the amount of timber in that area.

Photographic survey of the outlets of the Lake of the Woods in the vicinity of Kenora.

Photographic Survey of the Back river north of the island of Montreal.

Aerial photography at Devils Gap, in the area between lake Minnewanka and Bow river, Spray lakes to the Bow river and at Kananaskis and Horseshoe falls on the Bow river.

Photography along the courses of the English and Winnipeg rivers in Manitoba from Lac Seul to lake Winnipeg showing power sites, rapids, channels, etc.

Similar work on the Nelson river, Sea River falls, Whitemud falls, Chain of Rocks raps, Manitou raps, Chain of Islands chute, Birthday raps, 1st and 2nd Gull raps, 3rd and 4th Gull raps, 1st, 2nd and 3rd Kettle raps, Upper and Lower Long Spruce rapids, Upper Limestone raps, Lower Limestone raps, and on the Saskatchewan river, Grand rapids and Meadow portage.

Photography on the Sturgeonweir River watershed.

Aerial photography in the Maritime Provinces over the Nipisiguit river, Musquash Development, St. Margarets Bay Development, Bear River, Roseway river, East River Sheet harbour.

DEPARTMENT OF MINES

Geological Survey

Photographic reconnaissance in the delta of the Fraser river below New Westminster.

Transportation of supplies to survey parties working in northern Manitoba and Saskatchewan.

DEPARTMENT OF CUSTOMS AND EXCISE

Continuation of patrols from Vancouver Station for the prevention of smuggling by vessels incoming and outgoing to the Orient.

DEPARTMENT OF AGRICULTURE

Transportation of field parties investigating white pine blister rust in the coastal regions of British Columbia.

INTERNATIONAL JOINT COMMISSION

Vertical and oblique photography of the streams crossing the international boundary in southern Alberta. This work to be undertaken in conjunction with similar work for the Reclamation Service and Topographical Survey Branch, Department of Interior.

DEPARTMENT OF INDIAN AFFAIRS

Transportation of treaty money paying-parties to Nelson House, Split Lake, Port Nelson, Churchill, Cross Lake, Oxford House, God's Lake, Island Lake, Norway House, Fort Alexander, Black River, Hollow River, Little Grand Rapids, Deer Lake, Pekangekum, Bloodvein, Berens' River, Poplar River and Grand Rapids.

In addition to the above programme of work arranged for at the conference, plans were completed for the following operation on repayment for the Provinces.

Provincial Government of British Columbia

Continuation of work carried out during 1921, including forest fire patrols, transportation of fire fighting parties and appliances; the maintenance of such parties in inaccessible places; photographic reconnaissance and other similar work.

Provincial Government of Ontario

The operation of a complete system of fire patrols over an area lying south of the Ottawa river, lake Nipissing and French river from Georgian bay to the Ottawa river at Pembroke, to the southern edge of the forest country in that region.

Provincial Government of Quebec

Continuation of forest patrol and survey work in the forest areas lying north and west of lake St. John and their extension to areas on the north shore of the Gulf of St. Lawrence as required.

One noteworthy feature of the Conference was the insistence of practically all branches represented, of the importance of operations in the MacKenzie basin. No doubt exists in the minds of practically all of the Government services for whom the Air Force is working, that there is no more useful field for operations than in that district. Communications there are poor and distances are great. The length of time taken to reach the scene of operations unduly shortens the period during which field work can be undertaken each

year. Unfortunately financial considerations did not permit of the operation of a service in this territory during 1922. There is no doubt, however, that every effort should be made to enable a flying service to be started in that district. It will, in the opinion of those best qualified to judge, increase the efficiency of all branches of the Government working in that territory.

Another important feature was the increased demand for aerial photography. The work done during 1921 for the International Joint Commission along the line of the proposed St. Lawrence waterway has shown the usefulness of this class of work. It gives an exact representation of the country which can be used for the revision of existing maps and the preparation of new ones. On practically all Stations an increased demand for both vertical and oblique photography was experienced. In Alberta this was specially true. A large programme of work was planned at the Conference for making mosaics of the principal streams flowing east from the Rocky mountains to the settled prairie country. The conservation of the water supply on the prairies, and the extension of irrigation facilities in that country, are of great importance. The branches concerned recognized that aerial photography could give them detailed information as to the streams, only obtainable otherwise by most intensive ground work, necessitating large field parties and considerable expense.

The extension of the fire patrols and their modification as necessary to increase the efficiency of the system was considered and arrangements made with the Forestry Branch for two refuelling bases in Alberta, one at the northern extremity of the patrol at Eckville and the second at Pincher creek in southern Alberta. The opening of sub-bases at Norway House, Man., and Le Pas, Sask., to increase the areas covered in the Lake Winnipeg district, was agreed on. Plans were also discussed for the extension of the patrols into northern Saskatchewan by the establishment of a sub-station on Cowan lake. The necessity of this extension was urged by representatives of the Forestry Branch. Funds, however, did not permit of this being done.

The great majority of the items arranged for in this programme were carried out successfully. Financial conditions prevented some of the extensions proposed being put into effect, whilst in the other cases lack of suitable equipment and adverse weather conditions prevented the completion of the full programme.

A short summary of the work done at each station is given below. Maps illustrating the operations will be found on page 36, Western Canada, page 39, Central Canada, and page 50, Eastern Canada.

Vancouver, B.C.

Vancouver Air Station was established in the summer of 1920 on part of the old Naval Reserve, on English bay at Jericho Beach. The Provincial Government of British Columbia, to whom the land had reverted when it was no longer required by the Imperial Government as a Naval Reserve, granted the use of the property, free of charge, for the purpose of establishing the station. The site is an admirable one in every respect. The only work of a permanent nature so far erected is the slipway for launching the flying boats and seaplanes, and a concrete platform for handling them on the Station. Canvas Bessoneau hangars for the storage of machines and material had been erected at each end of this platform. This accommodation was only temporary and a permanent structure of steel and wood is now being erected to provide accommodation of a more permanent character. This was urgently necessary as the machines and equipment were fast deteriorating. The canvas hangars provided wholly inadequate shelter in the damp climate of the British Columbia coast. The new hangars will enable several flying boats to be stored ready for use and, in addition, will provide for workshops and storage accommodation for spare parts. The other buildings on the Station are of wood and consist of an

office, storehouse, garage, oil store and pigeon loft. A permanent fuel tank of 5,000 gallons' capacity has been erected on the Station and suitable arrangements made for refuelling machines with a minimum amount of labour.

The staff employed during the flying season was the superintendent, Squadron Leader C. MacLaurin, D.S.C., two pilot navigators, twelve mechanics, one storekeeper, one photographer, and three other miscellaneous employees, making a total of twenty. The equipment of the station included two F. 3 twin-engine flying boats and three H.S. 2L single-engine flying boats. The F. 3 boat is used for long-distance patrols, for the conveyance of fire-fighting parties and their equipment, and the H.S. 2L. machines for shorter patrols, photography and work where a useful load not exceeding 800 pounds is required.

The work done from the station during the year included patrols for fire protection for the Provincial Government of British Columbia. During the months of June, July and August, 57 patrols, of a total duration of 116 hours 3 minutes, were flown. The fire conditions were extremely bad in the coast regions of British Columbia during July owing to the unusually dry weather experienced. The following extract from a report by Major L. R. Andrews, District Forester, Vancouver, B.C., shows the nature of the work and the results obtained.

Extract of Report From Major L. R. Andrews, District Forester, Vancouver, B.C.

The 1922 fire season commenced early with an unprecedented period of drought, extending from May 25 to August 10. After June 1, the visibility, owing to smoke, was exceedingly poor. Fires started on the average of twelve weekly and in the middle of June as many as fifty-seven new fires were reported in one week. The smoke was so dense that reports of practically every flight were noted "Visibility poor".

The plans for 1922 proposed the use of aircraft principally on (1) supervision of fire fighting; (2) transportation of fire fighters and equipment; (3) general supervision of a Field staff spread over twenty-two million acres; (4) Fire detection.

No regular daily patrols were planned strictly for fire detection as the machines available were not suitable, owing to poor performance in climbing and cost of operation. In addition, the situation soon developed whereby owing to smoke the visability was against the success of any such effort. Appropriations were authorized covering about 100 hours flying time. The work was to be carried out by the Jericho Beach Air Station and paid for out of allotments at fixed rates per hour for the time the machines were actually in use.

The actual work carried out, included five trips on fire detection. These trips were not on any regular patrol, but were special trips of discovery ordered on information, or to obtain definite information where no reports had been received. A distance of eight hundred and eighty-two miles was covered on this work and the light three-passenger machine was used. Eighteen trips of fire-fighting inspection were made and a total of forty-four hours ten minutes was flown, covering two thousand, six hundred and ninety-three miles. Seven flights were made on actual fire fighting. Forty-five fire-fighters were carried to various fires. The flying time on this work was fifteen hours, thirty-eight minutes, with a distance flown of nine hundred and ninety-eight miles.

On general supervision of Field Staff, eight trips were made, with a total flying time of seventeen hours, twenty-one minutes. Forty-three passengers were carried, covering a distance of one thousand and fifty-nine miles.

On one of these trips the Minister of Lands, accompained by the Chief Forester, made a trip of inspection of the district at the commencement of the season. The fire protection organization was reviewed and a number of officers met at various points. The trip took less than two days and about three-quarters of the district was covered.

The total flying time for the season of 1922 was 105 hours 51 minutes. One hundred and ninety-seven passengers were transported, a total of six thousand six hundred and six miles.

One trip was made on timber reconnaissance, covering the watershed of the Capilano river.

One trip was made on Growth Study work locating areas of second growth and one trip was made delivering Proclamations on July 9, requiring operators to close down, in view of the extremely hazardous situation.

From the writer's point of view the quick means of transportation provided in many cases was of inestimable value. On one trip four fires were visited on which there was an aggregate payroll of $2,000 a day. As a result of this trip and of being able to fly over the

fire lines, survey the area burned over, determine direction of the fire and locate natural fire breaks in the path of the fire, the crew of two fires were taken off and the aggregate payroll of the fire-fighters of these fires reduced to about $500 per day. The distance covered on this flight was one hundred and ten miles, and fires visited were as much as fifty miles apart in one day.

Members of the permanent fire organization were taken over their districts during the period the fires were burning. The log on one trip is interesting to note and reads:—

> "I leave water with Supervisor X as passenger. Supervisor examines fire. He decides to let it burn itself out. I patrol the whole of Jervis inlet at a height of 4,000 feet. I fly over Horseshoe lake to observe fire there. This fire is burning fiercely. The fire which has been burning west of Powell river is out. Circle to give supervisor view of Horseshoe lake fire. We circle very closely to fire and can see tank cars and locomotives, etc., in charge of fire-fighters. Thunder Bay fire is burning high up a mountain, mostly in second growth. Supervisor decides to let it burn itself out, as it is too expensive and difficult to fight. I land supervisor and leave him here. I proceed west. I observe small fire on the west of Cranberry lake. Conditions not thought to be dangerous. I observe small fire on west side of Reef Point, in slashing. Green timber not in danger while wind is blowing from east. I observe fire on Thurlow island, north of Knox bay. I land and pick up district fire inspector. I leave water and fly to mouth of Salmon river. I fly about a mile up the river and observe small fire, apparently fire under control. I fly over Hardwick island up to Topaz harbour to observe fire at Hidden lake to northward. Return to windward to Knox bay fire and let inspector make examination. I land and inspector goes ashore."

This flight occurred on the 20th of June. The machine was in the air five hours and a half and covered a distance of three hundred and forty miles in two supervisor districts. The supervisors in question were able to get a birdseye view of the situation in their district and were landed at fires to get in touch with the fire boss in charge with a better knowledge of how the fires should be handled.

During one trip of inspection the machine reported twelve new fires. Information on four of these fires was new and was transmitted to the district ranger in question within a very short time.

One of the district inspectors wrote in on June 20:—

> "Seaplane picked me up at Pender harbour at 11.15 a.m. We flew around to Pender harbour then up Jervis inlet to the fire at Deserted bay; returning we flew over to the Sliamon, Texada island—Island Fires, landing at Stillwater. Time taken for this flight was two hours forty minutes."
>
> "A wonderful view of these different fires was obtained and their extent and condition instantly recognized. This trip by launch would have taken me two days, and to get the same idea of these fires would have taken over a week. I was able to observe three-quarters of my district from the air and gain actual knowledge which could not be had in any other way. No new fires were observed on this trip, but very quick action could have been taken if they had. I would say that flying over the district is a big help."

Possibly the most outstanding feat of the season was the transporting of fire-fighters to Buttles lake fire in the centre of Vancouver island. This fire was reported on the 28th of July. To get into this lake with a crew of men would have required a two-day trip and construction of about fourteen miles of trail over difficult country. By the time the crew arrived in all probability the fire would have been of such a size that it would have been impossible to have taken in sufficient additional men to have fought it. The big machine and emergency fire-fighting equipment were wired for. The equipment consisted of a portable pump and set of tools. These were loaded together with twelve hundred feet of hose, a sixteen man tent, six shovels, six mattocks, six axes, camp outfit and provisions for six men for two weeks. Four fire-fighters were carried also, in addition to the crew of the machine. The total load on this trip was four thousand eight hundred and ninety-five pounds. Visibility was very poor but the machine rose to the height of one thousand feet and hit across Vancouver island in the direction of Buttles lake. The route following the Campbell river to Campbell lake was taken, crossing the Campbell river fire, then following the Elk river and landing in Buttles lake about fifty-four minutes from Campbell river. Equipment and personnel were put ashore at the fire in collapsible boats. The machine then returned to Campbell river and picked up three more fire-fighters and took them into the fire. The fire-fighters were landed at four in the afternoon, fought fire all night, surrounded the fire with a fire trench and got the pump into action. The fire was practically under control in the morning. The crew were left on the fire for two more days and on the

fourth day the machine went in and took the crew and the equipment out. The gasoline taken in for the portable pump was used as extra fuel and one man was left to patrol the fire.

The total flying time for this job was about ten hours. The total passengers transported on the three trips was forty, including the crew. The total miles covered was eight hundred and thirty-six. On the trip out from the fire twelve passengers were taken in addition to the crew at one time.

On July 9, the Minister of Lands issued an appeal to the logging industry that in view of the extremely hazardous situation it was considered advisable that all industrial operations in the woods should cease for a short period. This proclamation was issued Saturday, July 9. On July 10, over one thousand operations had been notified of the proclamation. This was made possible to a large extent owing to the use of the airplane.

After the rains of August 9 and 10, all the fire-fighting crews in the district were laid off. When the rain stopped August 12, special trips of inspection were made by airplane covering all of the one hundred or so fires that had been burning fiercely three or four days previously, with a view to finding out what new outbreaks could be expected. At this time of the year continued rains could not be counted on and it was essential to be ready at a moment's notice to clinch the work of the rain while fires were controllable and prevent them getting a fresh start.

Sixty-one hours flying was carried out for the Department of Agriculture, in connection with their investigation of the white pine blister rust outbreak in British Columbia. The officer in charge of the field parties on this work writes as follows: "Our staff is so small, and the disease has been found to be so much more prevalent than we had expected, that we were very doubtful of our ability, with the ordinary methods of transportation available, to cover all the infected territory. However, with your help in reaching more or less inaccessible places, in a minimum of time, we have been able to do much more effective work."

The region covered included the Chilliwack district, Cultus Lake, Qualicum Beach, Quadra Island, Alert Bay, Nimpkish, Thurston Bay, Wellbore, Squamish, Jervis Inlet, Harrison Lake and Alta Lake.

For the Department of Customs and Excise between April 6 and October 9, 27 patrols, totalling 62 hours and 46 minutes flying, were successfully carried out. The object of these patrols is to escort liners arriving from, and departing to, the Orient, beyond the narrow waters. This prevents members of the crew or passengers on the ships throwing overboard packages of drugs, buoyed and made up in water-tight covers, at selected spots where they are picked up by launches and landed at some out of the way spot on the coast. The Collector of Customs, Vancouver, reports that the difficulty of smuggling has been much increased by these patrols. Not every ship is so escorted, but only selected vessels, at intervals, and without warning. Smugglers are therefore unable to make arrangements for smuggling by any particular boat.

Transportation work in connection with the primary triangulation scheme from Vancouver, east along the main line of the C.P.R. for the Geodetic Survey Branch, Department of Interior, was carried out as occasion required. During June and July 21 hours flying was carried out on this duty.

Owing to extremely poor weather the programme of photographic operations on this Station was limited. The smoke from forest fires rendered it impossible to get good pictures until well on in August. After that progress was made and photographic work carried out for the Department of Public Works, Geological Survey, and Department of Defence. The largest operation was that of making a mosaic of the Fraser River valley in the Nicomen Island district to show the Sumas reclamation work. Five hours, 10 minutes flying enabled this work to be satisfactorily completed and a remarkably fine picture, showing all the topographical details, was obtained.

No flying operations were carried out during the season from Kamloops or Sicamous for the Dominion Forestry Branch over the reserves in the rail-

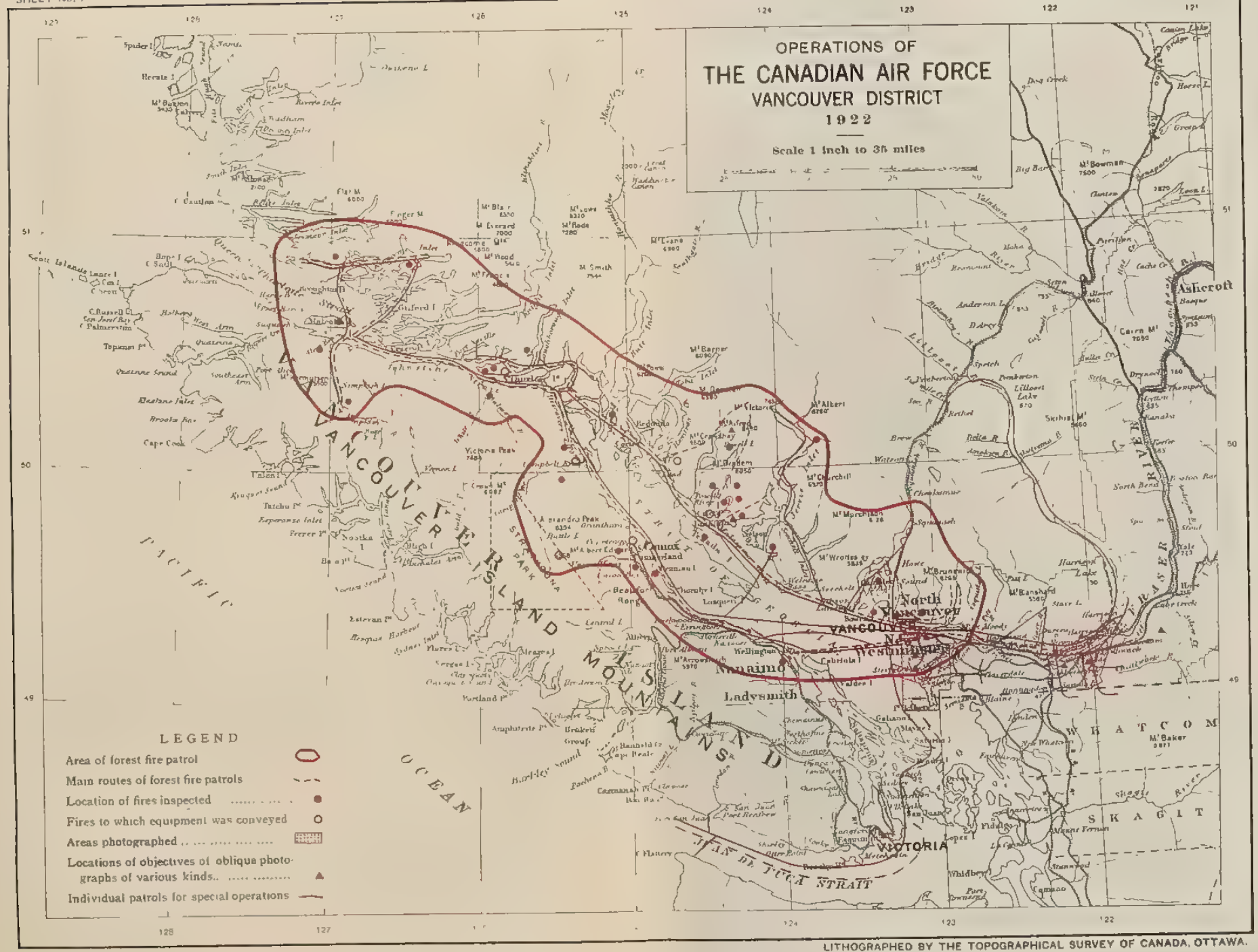
way belt in the interior of British Columbia. The usefulness of aircraft in that country had been amply demonstrated during the two preceding seasons and plans had been made to continue the work during 1922. However, as certain matters under dispute between different interests in that district were being investigated by a commission, it was not considered advisable to fly there until the investigation was completed.

An unfortunate accident occured on September 11 in which Squadron Leader C. MacLaurin, D.S.C., Station Superintendent, and Mr. Duncan of Vancouver lost their lives. This was the first accident on the Vancouver Air Station and indeed the first fatal accident to any flying boat or seaplane in the Government service during the three years operations totalling many hundreds of hours flying. Major MacLaurin's death was a great loss not only to the Government service but to aviation generally. He was one of the first six pilots to proceed overseas from Canada to the Royal Naval Air Service. He had a brilliant war record and was a pioneer in the development of the civil uses of aircraft in Canada. No one had done more to open up new fields for aviation. His work on the British Columbia coast in developing the new form of transportation was uniformly sound. Squadron Leader A. E. Godfrey, M.C., A.F.C., was appointed officer commanding the unit in November, 1922, to fill the vacancy.

High River, Alberta.

The main purpose of this Station is the patrol of the forest reserves on the eastern slopes of the Rocky mountains for the detection of forest fires in these areas. The importance of protecting this district from denudation of its forests is very great. The streams which water the Prairie Provinces all have their source within it. The maintenance of these forests is essential to the conservation of the water supply and its regulation. The Government took measures some years ago to create forest reserves throughout this region to ensure their protection against fire and have built up a ground organization for that purpose. Realizing the assistance aircraft could be in the detection of fires, arrangements were made in 1920 for the establishment of a Station and the conduct of experimental operations in the fall of that year. The site chosen was at Morley, Alberta, on the main line of the Canadian Pacific Railway. The trials showed that this location was too near the mountains. The disturbed atmospheric conditions produced by the close proximity of the higher ranges made flying difficult and landings somewhat dangerous. It was, therefore, decided to move the Station further east to the edge of the foot-hills, where a landing ground could be found in level prairie country, sufficiently close to the reserves and yet free from the disadvantages of the aerodrome at Morley.

An admirable site was chosen a mile from the town of High River, Alberta, and in 1921 a beginning was made with the erection of a Station. Bessoneau canvas hangars were used at first. These have been replaced by structures of wood with concrete foundations. Suitable workshops and storehouses have also been built and the Station at High River is now admirably equipped for its work. Wireless telephone communication is used between the Station and machines on patrol. The Station is connected with the extensive system of ground telephones installed by the Forestry Branch for communication with the different forest ranger stations. It is therefore possible to communicate instantaneously any signs of fire seen from the air to the nearest ranger station. This ensures prompt action being taken to deal with incipient outbreaks. During 1921 regular patrols were carried out daily throughout the summer months. The district is divided into two areas, northern and southern. To increase the efficiency of the service in 1922, landing grounds were chosen, one at Eckville in the northern section, and the other at Pincher creek in the southern



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section, so that machines might carry out a double patrol each day, going out in the morning and covering the district, landing at the sub-bases, refuelling and returning to High River in the afternoon. The machines used are De Haviland IV aeroplanes fitted with Rolls-Royce Eagle VIII engines and carrying wireless telephone sets. They have been modified as necessary for their work and have given excellent service during the three years they have been in operation. Practically every patrol undertaken has been completed and no forced landings have occurred during three years' operations. During the past season 495 flights were called for and none were missed or curtailed by mechanical troubles. Mechanical efficiency is essential in a country of this nature, where the terrain is rough and safe landing grounds are few and far between. In addition to the single-seater patrol machines, a two seater machine is always available, so that foresters can be taken for observation and inspection flights as required. A specially equipped photographic machine, fitted for vertical or oblique photography, is also stationed at High River and a large programme of photographic operations has been carried out during 1922.

The staff of the Station during the flying season was the Station Superintendent, Squadron Leader G. M. Croil, A.F.C., four pilots, one photographer, one storekeeper, 18 mechanics and four other miscellaneous employees, making a total staff of twenty-four.

The principal work was, of course, the daily patrols in the Bow River, Clearwater, Crowsnest Reserves and Waterton Lakes Park for the Forestry Branch, Department of the Interior. The first patrol was made on May 30th and last on November 26th. A total of 906 hours 15 minutes flying was carried out on this duty. This included vertical and oblique photography for the Forestry Branch in Dutch Creek, Ptolemy, North Kootenay and Middle Kootenay passes; vertical photography in Dutch Creek valley and between Dutch and Racehorse creeks, and observation flights as necessary for Forestry Branch.

Aerial photography was carried out for the Canadian National Parks Branch, including a mosaic of the town of Banff and its vicinity, and oblique pictures of the principal valleys in the Rocky Mountain Park. Pictures taken in the Jasper Park area for the Geodetic Survey were also made available for their use.

For the Water-Power Branch flights totalling 17 hours and 35 minutes were made and photographs taken under the direction of their officers of the various streams in the Bow River drainage basin, including Devil's Gap, Lake Minnewanka district, Spray River valley and the headwaters of the Ghost and Red Deer rivers.

An interesting operation was carried out for the Geodetic Survey, Department of the Interior. This branch was laying down a primary triangulation scheme from the Yellow Head pass northwest, along the line of the continental watershed, from mount Robson to the intersection of the 120th meridian with the continental divide. A large part of this area was unmapped and little was known regarding it. To facilitate the work of the survey parties, arrangements were made for reconnaissance flights in which the officer-in-charge of the survey could be carried as observer. He would thus have an opportunity of obtaining a bird's-eye view of the country to be traversed, the best lines of travel through it and its general configuration. The knowledge gained would assist him materially in travelling through the passes and in selecting points for observation stations in connection with the survey. The photographs taken during the observation flights would also furnish a valuable guide during the progress of the work.

Mr. A. O. Wheeler, Commissioner for British Columbia on the British Columbia-Alberta Boundary Commission, charged with the delimitation and marking of the boundary, also applied to be given an opportunity to fly over the country as observer. Flights totalling 19 hours and 50 minutes were successfully carried out on this work and the results have been of great value to the services concerned. Mr. H. F. Lambart, in charge of the work for Geodetic Survey, had previously undertaken similar reconnaissance flights from Vancouver with satisfactory results. His further experience in northern Alberta confirms his previous opinion that the use of aircraft for reconnaissance work of this nature is of great value. It enables the engineer to determine in advance the best lines of travel through a country and helps him to select the stations calculated to give him the best scheme of triangulation. Mr. Wheeler, whose long experience in photo-topography in the mountain areas renders his opinion of great value, in the following short extract from his report shows the possibilities of such flights.

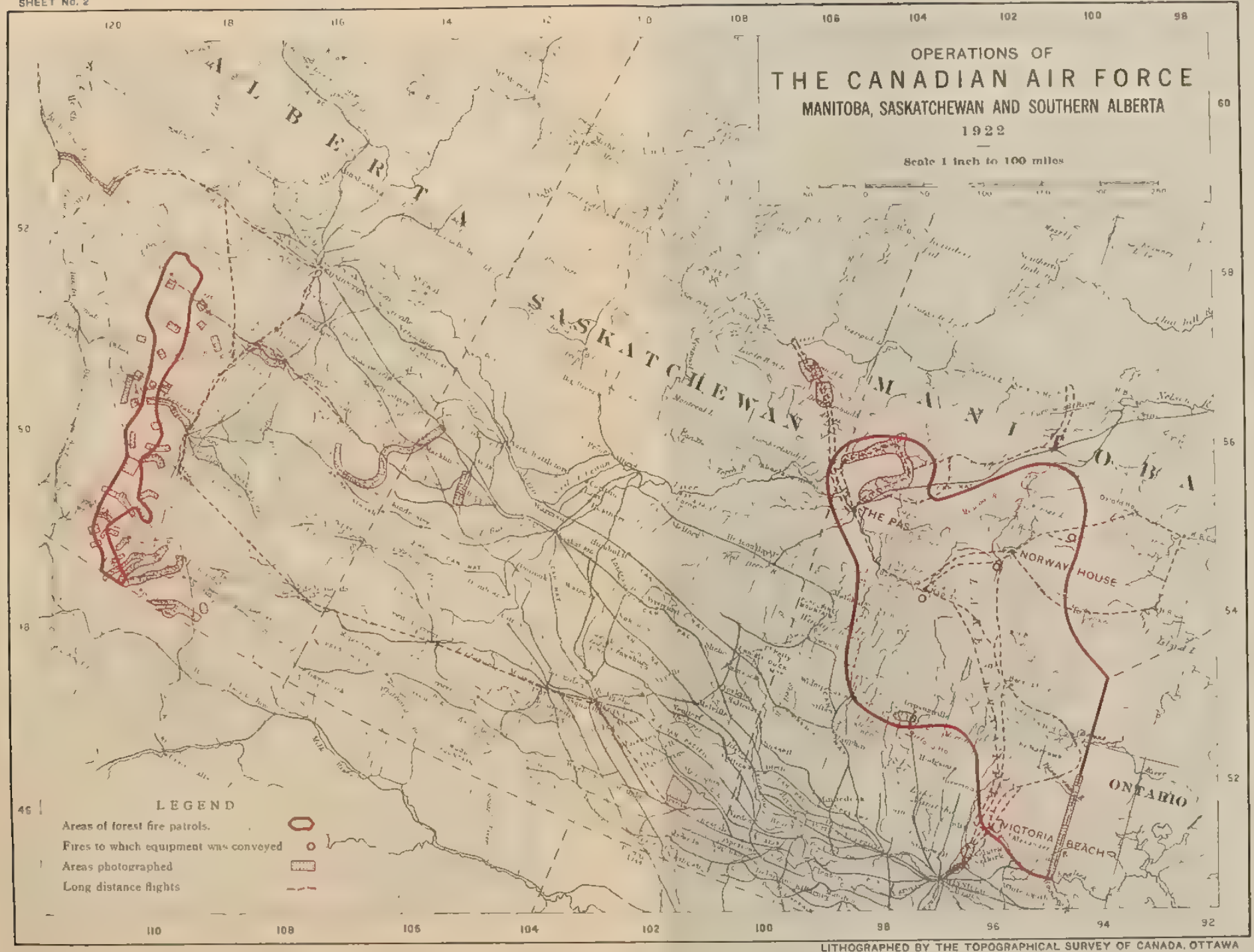
> "As a means of mountain reconnaissance the aeroplane offers exceptional facilities. Given a clear day and the ability to keep to known landmarks it is to a topographer a study of a living map, the most accurate that can possibly be had. I was enabled to get a clear conception of the country my future surveys would cover and the nature of the access to them, and in one case was able to obtain information that will prevent a considerable loss of time. In conclusion, I may say that the aeroplane service can be applied to distant and difficult surveying work with great advantage and I should think could be used as a means of saving expense."

For the Reclamation Service, Department of the Interior, a large programme of aerial photography was carried out over the streams rising in the eastern slopes of the Rocky Mountains. This work entailed 43 hours 30 minutes flying and included mosaics of the Waterton river and lakes, Belly river, St. Mary's river and lakes, Sherburne reservoir and Swift Current creek, parts of the Saskatchewan, Red Deer and Clearwater rivers and proposed dam sites on the Battle river and Tail creek. Photographic reconnaissance for the purpose of locating reservoir sites on several of the streams in the district and continuous oblique photographs of others was undertaken. A complete photographic record of the courses of the more important streams in this district has now been obtained. This cannot but be of great value to the Reclamation Service in its work of preparing plans for the conservation of the water in this district and schemes for irrigation.

For the Topographical Surveys Branch, Department of the Interior, mosaics of the Bow river from Kananaskis to Calgary, of township 28, range 7, west of the 5th meridian, and of the Moose Mountain Forest Reserve were made for the purpose of supplying topographical detail in connection with the survey of these areas.

Photographs of the mountain areas at the head of Ghost river and Warparous creek, the Gap, and the Red Deer river were also taken for this service to enable them to obtain topographical detail of these areas, necessary for the completion of existing surveys. Forty-three hours and ten minutes flying was necessary to complete the operations for this Branch.

The International Joint Commission are interested in all international waters and the results of photography undertaken for other branches on any international streams has been available for their information. The Secretary of the Commission was taken as observer on a flight over the district including the Waterton lakes and Castlemount river, St. Mary's and Oldman rivers to enable him to obtain first-hand information and a bird's-eye view of these areas.



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The results of the photographic programme carried out at different stations are of great importance. Mosaics are being prepared, correct to scale and controlled by township and section lines, by the Topographical Surveys Branch. All photographs taken are being examined and compared with existing maps. Where these are incomplete and further information can be obtained from the photographs, the maps are being revised accordingly. (A report on the progress made in the utilization of aerial photography for survey purposes will be found on page 56.)

Manitoba Area.

In the great area lying between Hudson and James bays and the valley of the Mackenzie river, tremendous possibilities exist for aerial transport. Communications are still of a most primitive type. There are no roads and, except on one or two of the larger lakes and rivers, no steamboats or launches. Travel by canoe and dog-team is the only method of transportation. The development of this area is now commencing. The forests are becoming of commercial importance and with the increase of population in the settled prairie country to the south, will become before long vital to the prosperity of Central Canada. A large part of the area is unfit for settlement, but is capable of growing timber and pulpwood in immense quantities. The problem of conservation and protection from destruction by fires of the timber over a region such as this, remote from the railways, sparsely populated and difficult of access, is a difficult one. The foresters responsible for this work realize that aerial transport can solve many of their problems. The Government services engaged in the exploration and survey of this great area also recognize that their work could be greatly facilitated by the use of flying boats for transportation. After watching the results of the trial operations carried out in British Columbia and Alberta in 1920, the Forestry Branch, Department of the Interior, requested that the Air Board establish a Station on lake Winnipeg with a view to assisting in their work in the forest area surrounding lakes Winnipeg, Winnipegosis and Manitoba.

A site was chosen at Victoria Beach, at the end of the Canadian National line running up the eastern shore of the lake. A temporary station was erected there during 1921 and operations were carried on throughout the season of fire hazard during that year. In 1922 it was decided to extend the operations by the establishment of sub-bases at the north end of the lake, at Norway House, and at Le Pas, on the Saskatchewan river and Hudson Bay Railway line. This has made possible the extension of patrols into districts still more remote from civilization and has enabled more intensive fire patrols to be maintained. The Staff during the flying season was as follows: In command, Squadron Leader B. D. Hobbs, D.S.O., D.S.C., four pilots, one photographer, one storekeeper, 24 mechanics, 7 other miscellaneous employees. Flying was carried out from May 17 to October 16 from the three Stations. The total flying time was 307 hours 40 minutes. Great difficulties had to be overcome to enable this amount of work to be carried out.

The only machine available for long distance work was the F. 3 Boat. This machine is an early type of twin engined boat and has always been difficult to operate. With the small crews available for handling such a large machine and the few facilities in the way of slipways and protected anchorages for refuelling, the task of maintaining the patrol has thrown a great burden on the staff in this district. Only by most strenuous efforts have the machines been kept in the air. Until more modern types of machines, smaller and easier to handle, but at the same time capable of giving the same service are available, operations in this district cannot be conducted with complete success. Continuity in fire patrols during the season of hazard is essential for its success.

Without equipment which can be relied on, this is impossible to obtain. It is hoped that next year new flying boats of a modern type, smaller and more efficient will be available. If this be the case, full satisfaction can be given, but until then the service cannot be maintained on a scale commensurate with the effort put forth. The results achieved, even under the handicap of inadequate machines and the absence of ground facilities such as workshops, slipways, hangar accommodation, have proved beyond a doubt that the solution of transportation during the summer months in this region is the flying boat. By its use, the efficiency of the forest protection and survey operations, the exploration and mapping of the country and its administration generally, can be greatly assisted. Journeys which, previous to the establishment of the Air Stations, took days and sometimes weeks to perform, can now be carried out with ease, comfort and safety in a few hours. Observation for fire protection over areas, which it was physically impossible to reach by the old methods of transportation, are now carried out with ease. The exploration and mapping of the area, which has hardly commenced, will be it is hoped greatly simplified by the use of aircraft. By ground methods it must take the work of generations and even then will be imperfect and unfinished. Forest fires, which previously burned unchecked, can now be fought by parties, transported and maintained at the scene of the fire, by air. Wonderful instances of this have already occurred within the areas patrolled. In short, the introduction of aircraft will revolutionize travel and administration in such districts before many years elapse.

The greater part of the area lying north and east of the lakes is a flat country intersected by numerous watercourses and lakes. A very large proportion of the surface is water so that it provides an admirable field for the use of flying boats and seaplanes. Good landing grounds are available almost everywhere. The only drawback is that the lakes are shallow and in many cases lack sheltered anchorages for mooring machines. The flat nature of the land makes observation from the ground difficult. Fire protection by canoe or motor launch patrol suffered because of the small area which could be observed while travelling through the country. The view was confined practically to the immediate banks of the river or lakes traversed. From the air, however, the widest expanse of country may be seen. The atmosphere is generally clear during the summer season and the whole country from horizon to horizon is under observation. Outbreaks of fire may be sighted over an area of from two to three hundred square miles at a very moderate altitude. Should smoke be seen in the distance, the machine can be headed towards it and investigation made immediately. If the fire is a small one, the crew of the machine with the forestry observer can extinguish it. If it is too large to cope with unaided, further parties of men may be transferred by machine to the scene of the fire in a few hours time, with their fire-fighting equipment and can be maintained on the spot until the fire is mastered. During the past two summers numerous forest fires, which it would not have been otherwise possible to fight successfully, or in some cases even locate, have been mastered in their early stages and a large amount of valuable timber saved. The following short extracts from the reports of the Forestry Branch are of interest and show the attitude of the district rangers and patrolmen towards aircraft:—

Extract from Wireless Message received from the district Fire Ranger, Norway House:—

Five forest fires started to-day by lightning. By using plane for carrying crews to distant fires and canoes with "Evinrude" for close in fires, we will have fire-fighters at every fire to-night. We flew over every fire and were able to give instructions where the fires were and the best way to fight them two and a half hours after fires started.

Extract from a letter from the District Fire Inspector at Le Pas:—

Everything going along fine at present but miss the machine very much. I am starting on an inspection trip next week which will take me 12 days. We used to go over the same ground via seaplane and be back at The Pas at 10 a.m.

Extract from patrol Norway House 12:—

An item of interest was the comment of most white people encountered who say that the general effect of the patrol is to make trappers, especially Indians, very much more careful as regards their camp fires.

By arrangement with the Royal Canadian Corps of Signals, a wireless station has been installed in Winnipeg so that constant communication may be maintained between Forestry Headquarters and the district fire officers in the field throughout the area. This simplifies administration and makes it possible for the Superintendent of the Forestry Service to be kept in daily touch with the operations throughout the huge area under his supervision. Next season it is hoped that conditions will permit of the extension of the use of wireless so that machines in flight may keep in touch with their bases and in case of trouble to send for assistance. This will ensure the safety of the crews and is a very necessary precaution in a country still largely unexplored and uninhabited. Air patrols with wireless communication are a tremendous advance and enable the Forestry Officers for the first time to cover effectively the vast areas under their control.

In addition to the forestry work much transportation was undertaken for other services and a considerable programme of aerial photography was successfully carried out. For the Department of Indian Affairs in June, July and August twenty-one flights were made for Indian Agents paying treaty money in the Clandeboye and Norway House Agencies. The duration of these flights was 46 hours 45 minutes. A distance of 3,000 miles was flown. The points visited included Fort Alexander, Black river, Hollow river, Berens river, Deer river, Pekangekum, Grand rapids, George's island, the Bloodvein Reserve, Cross lake, Oxford lake, God's lake, Island lake and Thunder lake. On one of these trips one of the machines, while taking off in unchartered and unknown waters, hit a submerged rock and was severely damaged. Another machine was flown to its assistance and repairs successfully completed after three weeks' work. Valuable assistance was rendered by an Indian Chief and his band living in the neighbourhood in saving the machine and making the necessary repairs. The Department of Indian Affairs have expressed their satisfaction with the results obtained and are prepared to extend the payment of treaty money in remote districts by air, as our equipment and other operations permit, and to pay for the transportation given from their own appropriation.

For the Topographical Surveys Branch, Department of the Interior, flights for the transportation of Mr. Narraway, Controller of Surveys, totalling 14 hours and 9 minutes, were made between July 3 and 11. These flights are a remarkable instance of how inspection work may be simplified and extended in these areas. They were, in a large measure, not special flights but part of the normal fire patrol work for the Forestry Branch. An extract from Mr. Narraway's report on these flights is as follows:—

The flight, consisting in the neighbourhood of 1,100 miles mostly over unmapped territory, commenced at Victoria Beach, on lake Winnipeg, and ended at The Pas. No mishaps or delays occurred and the trip was made in ten days including six days spent at surveyors' camps. By ordinary methods of travel this inspection work would have taken practically the whole season and would have been expensive.

The first survey party to be visited was engaged in the surveying of the Manitoba-Ontario boundary. No reports had been received from this party and as they were in unexplored and unmapped territory only an approximate idea could be formed as to their

location. A very conservative estimate of the time which would be required in reaching this party by ordinary means of travel would be somewhat over two weeks and would have entailed considerable hard paddling and searching out routes and portages, the usual endless contest with mosquitoes, the difficult task of finding the party and a very restricted view of the country traversed. The trip was actually made in one hour and forty-five minutes and permitted of the sketching of the main topographical features and examination of the forest growth and by flying low, an unobstructed view of the completed boundary line was obtained and an estimate made of the difficulties encountered. The camp was located without any difficulty by the smoke from camp fires and a very easy landing was effected ending with the machine tied to trees less than twenty feet from the tents.

After a few days spent on inspection work, an exploratory flight was made along the boundary yet to be surveyed in order to decide upon definite plans for producing the line and transporting supplies. A knowledge of the available water routes for transportation in a case of this kind is invaluable and saves considerable expense and time and avoids much worry.

Perhaps the most interesting and useful part of the trip was north from Pas to the Churchill river and to the camp of the surveyor mapping the waterways of the district; the most interesting because of the wonderful views obtained of this country of lakes; the most useful because of the experimental photographic work which we were able to do. Flying over the course of the survey, oblique photographs were taken by the K2 camera at intervals of about two minutes. In some of the photographs the survey pickets are clearly discernible and in all of them the prominent land features surveyed can be accurately located. Using the survey of these main features as a control, the details of the shore line and the intricate mass of islands can be filled in from the photographs with accuracy consistent with the requirements. The surveyors were obliged to spend considerable time mapping the shore-line details and islands and even then could only obtain what was confined between the two shores. With the plane, the time required to get in the details, can be estimated in minutes instead of hours and some cases days, and the scope of the camera widens the survey to several miles on either side of the waterway and includes lakes and topographical features which otherwise would be left unmapped.

As a result of this trip I am of the opinion that invaluable service to surveying in unexplored and unmapped territories will be rendered in the future by the seaplane; in transporting supplies and men, thereby saving for the work many days of the working season, which is already short enough; in permitting reconnaissance and exploratory flights for purposes of planning surveys; in keeping in communication with the surveyors during the season; and in taking photographs along the course of the survey for filling in detail. To those who have a thorough knowledge of the ground conditions and experience in sketching and mapping such as surveyors have, the value of flights over the districts to be surveyed can scarcely be overestimated.

Since Mr. Narraway's return a systematic examination has been made of the photographs taken from the machine in which he made his inspection trips, with a view to evolving a method of transferring the topographical information shown on the photographs to the maps of the district. Most favourable results have been obtained. These may have very far reaching results in the exploration and mapping of large areas throughout northern Canada. A report on this work will be found in Report A, Appendix 1, page 58.

In addition to the photography carried out on Mr. Narraway's inspection flights, opportunity was taken, whilst the machines were on patrol for the Forestry Branch, to obtain oblique pictures of those districts of which the maps are at present incomplete. Much additional information has been made available and is now being plotted on the maps.

Vertical photographs were taken over the Ontario-Manitoba boundary to assist in the mapping of this line by furnishing further topographical details. Mails and supplies for the party were carried and transportation furnished for some of its members proceeding to or from the scene of operations during the summer. A total of 32 hours 49 minutes was flown on these duties for the Topographical Survey Branch.

For the Geological Survey a depot of 1,100 pounds of supplies was laid on Beaver Dam lake and the officer in charge of the party was taken for an extended observation patrol over the district in which he was working. The laying of additional depots of supplies and the transportation back to civili-

zation in the fall of the survey party was prevented through lack of machines to carry out this work. These operations required 4 hours 35 minutes flying. Opportunity was taken by the District Engineer, Department of Public Works, to visit water level gauges as necessary and for the transportation of their engineers in the district as the other operations permitted. Four hours and 45 minutes flying was undertaken for this department.

Photographs of the various falls and rapids along the course of the Winnipeg river from lake Winnipeg to lac du Bonnet were taken for the Water Powers Branch, Department of Interior. These form a valuable addition to their records and show the possible sites for hydro-electric power development and the natural conditions very clearly.

Algonquin Park Area.

In 1921, flying operations for the survey of the forest types in that part of northern Ontario lying north of the National Transcontinental Railway and immediately east of the Manitoba boundary, was undertaken from a temporary base at Sioux Lookout. During the survey operations serious forest fires occurred. The flying boats and personnel on the station were diverted from their survey work for a time to assist in forest fire fighting and the maintenance of parties engaged in that work at points distant from the railway. These operations convinced the provincial authorities of the value of aircraft as an aid in the detection and prevention of forest fires. A request was received from the Government of Ontario that an extensive operation should be undertaken during 1922 having this work as its main object. An agreement was arrived at under which the Air Force would supply the machines, equipment and personnel to undertake this work over an area of about 10,000 square miles south of the Ottawa river, lake Nipissing and the French river, bounded by Pembroke on the east and Georgian bay on the west and reaching as far south as the edge of the forest country in that district. The Provincial Department of Lands and Forests reimbursed the Dominion Government for the cost of the operation including the wages of all those employed, the cost of all consumable stores used, interest at 5 per cent on the equipment used, and depreciation at 10 per cent on the ground equipment and 20 per cent on the air equipment.

Two bases were established in the patrol area, one at Whitney in Algonquin Park, on the line of the Canadian Northern Railway, and the other at Parry Sound, on Georgian bay. Suitable anchorages for the flying boats were chosen, moorings laid and temporary accommodation secured for stores and other necessary ground work. The machines for the operations were prepared for the work at the Ottawa Air Station and on May 23 the first two machines left Ottawa for Whitney making a patrol over the forest areas en route. From that date until October 4, flying was carried on daily, except when wet weather warranted the forestry officer stopping the patrols. From Whitney 169 patrols were made during the season, totalling 407 hours 30 minutes, giving an average duration for each patrol of two hours 25 minutes, and from Parry Sound 73 patrols of a total duration of 168 hours 11 minutes. The operations in this district were in charge of Flight Lieutenant C. McEwen, M.C., D.F.C. His staff was as follows: 3 pilots, 2 storekeepers, 7 mechanics and 1 labourer; total for both bases, 14. The work was carried out in the closest co-operation with Mr. W. A. Delahaye, District Forester to the Ontario Provincial Government. The work done is shown in the following report from him.

REPORT COVERING AERIAL FOREST FIRE PATROL—ALGONQUIN DISTRICT

The operations covered by the following report were undertaken by the Ontario Forestry Branch in co-operation with Canadian Air Board for the purpose of investigating the possibilities of aircraft as a forest fire patrol. The machines for the Algonquin District

operated from Whitney, which is located on the old Canada Atlantic (Grand Trunk) Railway, midway between Ottawa and Parry Sound, where a widening of the Madawaska river offers excellent facilities for the operation of seaplanes. This district comprises some 5,000 square miles; but during the season of operations, which lasted from May to October, a patrol was carried on over some additional 2,000 square miles. During this time an effort was made to maintain a daily patrol over the area, excepting when the weather was prohibitive, and a double patrol on days when an extra menace, such as a prolonged drought or a severe thunder storm, demanded additional precautions. As the season progressed the results exceeded the most sanguine hopes of the promoters of the scheme.

The personnel furnished by the Air Board consisted of a station superintendent, two pilots, chief mechanic, two engine fitters, two riggers, storesman, stenographer, cook and cookie. The Forestry Branch supplied two forestry observers, and the whole operation came under the direct supervision of the district forester at Pembroke.

The equipment consisted of three H.S. 2L flying boats, one of which was later exchanged for an Avro, which had been fitted with pontoons for water service; and a second Avro was added towards the end of the season. A light out-board motor skiff was used for the convenience of the crews. Both of the above types of machines offered special advantages in the work undertaken; but in order to more thoroughly appreciate these advantages a slight understanding of the more salient features of each is essential.

The H.S. 2L is a flying boat of very sturdy design, having a heavy fuselage and a wing span of seventy feet along the leading edge of the upper plane. It is equipped with a Liberty twelve-cylinder engine of 360 horse-power. Its useful load consists of 140 gallons of gasolene, 10 gallons of oil, a crew of four men, and about 200 pounds of miscellany. Its average speed is sixty to seventy miles per hour. The radius of action is about four hours.

The Avro is a land machine equipped with floats, and this season was in the experimental stage. It is much smaller than the H.S. 2L type, having a wing span of approximately thirty-five feet. It is equipped with a Clerget Rotary nine-cylinder engine of 130 horse-power. The flying speed is about the same as the heavier machine. It carries a crew of two men, 30 gallons of gasolene, and 3 gallons of oil; and has a radius of action of two hours.

The working conditions during the summer were excellent. The extremely irregular topography of the district rendered flying at low altitudes difficult, but did not interfere materially with the work engaged in. Numerous lakes, occupying approximately seven per cent of the total area, offered ample landing facilities. Auxiliary re-fuelling stations were established at points throughout the district, but were used principally for emergency supplies and the longer patrols of the Avro machines. In no case did the weather hinder flying operations during the season to any extent, except during short periods when heavy, low clouds and low visibility rendered flying ineffectual. It is worthy of note that during such periods the usual accompanying precipitation or high humidity considerably lessens the fire hazard; and in no case during the season did any fire fail to be reported within twenty-four hours of its inception. When flights were limited to one during the day the most efficient hour at which to carry out the patrol was found to be about 4.00 p.m., as at that time the conditions favouring the visibility of a forest fire are usually optimum. Fires, when discovered, were reported either directly by landing at a Ranger Station, by dropping a message to the nearest dependable assistance, or by wiring from the aviation base on returning. Daily Reports were forwarded each day to the District Forestry Office at Pembroke, so that the district forester was in constant touch with the fire situation throughout his district.

Regular flying operations commenced on May 23, and continued till October 4. During this period of 135 days, 166 patrols, averaging 165 miles per flight, were accomplished. The average time in the air during each patrol was two hours and thirty-five minutes, which aggregate a total of 427·46 flying hours for the season, a total considerably in excess of any previously attained by a Flying Station in the Dominion. During this time eighty-four fires were discovered and reported.

Although the Whitney planes were used primarily as a fire patrol, the following examples that transpired during the season's operations will serve to emphasize the importance of these machines not only in detection but also in suppression of forest fires. On three or four occasions the chief ranger was enabled to size up the situation from the air, so that he could place his men most effectively on the fire. On another occasion when four fires threatened to get beyond control on a particularly windy day, the machine crew co-operated with the land forces in rushing additional equipment and a portable pump to the scene of the fires, and serious conflagrations were prevented. The resultant saving in timber and fire-fighting costs in very few of such cases would cover the cost of maintenance of this important auxiliary to the fire ranging staff. Other secondary work carried on included sketch mapping of burned areas and forest types, and aerial photography. Although no considerable work was done of this nature, enough was accomplished to appreciate the possibilities involved.

The particularly outstanding features of this department that cannot be too highly commended are its accuracy, its reliability, and its efficiency. Anyone who can read a good map intelligently should have no trouble in determining the location of a fire when viewed from the air to within a few rods of its situation. The certainty with which the fire may be classified with regard to size and possibilities enables the observer to determine the number of men and the amount of equipment required to combat it. It is probably the most dependable of any means of detection, since the ground haze which frequently renders visibility from look-out stations low, does not interfere noticeably with observations taken from the plane at average flying altitudes. When considering its efficiency a point which should not be overlooked is the moral effect on the people who are responsible for possibly fifty per cent of the fires. The sight of the plane each day is a constant reminder of the fact that the Government is spending vast sums of money in fire prevention and tends to make them more careful. Then, it acts as a restraint on those who might be tempted to take advantage of an opportune moment to burn fallow or other clearing operation that they know should have been done during a less dangerous season. It is noteworthy that during the latter part of September when so many small fires were burning in the surrounding districts as a forerunner to the disastrous fires of October 4, this district was practically free from any fire.

During the season's operations certain recommendations suggested themselves that would help to increase the efficiency of such a service. The Station could be advantageously equipped with one or two H.S. 2L flying boats and three Avros. These Avro machines should be fitted with a more dependable engine than the Clerget and the weight of the floats could also be profitably reduced. All machines should be equipped with wireless telephones. The Avros could do the reconnaissance and the large machines would be ready to be used in rushing men and equipment to a fire and for other special work. With a station situated at Cedar lake or Trout lake this squadron could cover the Parry Sound—Algonquin Districts and a large part of the Temiskaming—Temagami country. The whole operation should be absolutely controlled by a Forestry Officer who would arrange when flights were to be made and also the patrol to be covered.

(Sgd.) W. A. DELAHAYE,
District Forester.

The last forest fire patrol was made on October 4. The H.S. 2L boats were then flown to Ottawa Air Station for winter overhaul and the Avro machines to Allandale, on lake Simcoe, where they were taken from the water and shipped to Camp Borden. The personnel returned to Ottawa Air Station and have been employed in the overhaul and repair of the engines and machines for next season's work.

Roberval.

The Air Station at Roberval was established during the summer of 1920 at the request of the Provincial Government of Quebec, who furnished a site, free of charge, and have since erected substantial buildings on the Station for the housing of the staff and the storage of the equipment. The main purpose of the station has been the exploration and survey of the forest resources in the district lying north and west of lake St. John as far as the watershed to James bay and the protection of these areas against forest fires.

During 1920 and 1921 the Provincial Department of Lands and Forests voted a substantial sum towards the cost of the operations and during 1922 agreed to expend an amount not exceeding $20,000 on the work. The operations have been in charge of Flight Lieutenant W. R. Kenney, D.F.C. The Staff consisted, in addition to the officer commanding, of two pilots, one photographer, one storekeeper, eight mechanics and five other employees, making a total of 18 during the flying season. Owing to delays in reaching an agreement as to terms of operation, the work did not commence until June 30. It continued from that date regularly until October 22. During this time 141 flights totalling 186 hours 30 minutes were made. As the region regarding which detailed information was required lay nearly 100 miles northwest of Roberval it was decided to establish a sub-base at Stacker lake. This provides an admirable landing place with suitable sheltered anchorages and is located in the centre of the area to be surveyed. Stacker lake

is five days' canoe journey from Roberval and the maintenance of the machines there involved the transportation of gasolene, oil and other supplies necessary to keep the machines in operation, and, in addition, food, etc. for the staff stationed there. It was decided to carry this freight by air and one machine was employed continuously on transportation work for the maintenance of the sub-base, while the other two machines on the station carried on the flying for the forestry engineers. This plan worked admirably without hitch during the whole season. The machine on transportation work carried out fire patrols on its journeys to and from Stacker lake so that they served a double purpose.

The survey work was done by the forest engineers of the Provincial Government, by sketching from the air, supplemented by oblique and vertical photographs. The maps of this part of the country are incomplete. Only the main water courses have been surveyed and the season's work has enabled much additional topography to be added to the map, while the timber types have been sketched over a very large area, reaching as far as lake Mistassini. Caches of petrol were laid at Fileaxe lake and Rat lake, north of the village of Mistassini, to enable the machines to refuel while on patrol and thus increase their range from the base.

In addition to the main operations in the country surrounding lake St. John, detached operations for similar purposes were carried out on the north shore of the gulf of St. Lawrence. A machine was despatched, at the request of the Provincial Government, from Halifax Station and flown to Ellis bay, Anticosti, en route for the Natashquan river, which flows into the gulf from the north opposite the eastern end of that island. Unfortunately engine trouble was experienced with the Halifax machine en route. As the season was late and it was essential to get the information required, it was decided to detach a machine from Roberval to do the work and send the first back to Halifax. No risks can be taken on an operation of this nature so far from any base. The country is largely unexplored and unsettlted and a forced landing in the hinterland might mean the loss not only of the machine, but, what is much more important, of the crew as well. The second machine left Roberval on August 31 and proceeded via Chicoutimi, Tadoussac and Ellis bay to Natashquan. This journey took eight hours 50 minutes. A reconnaissance of the country flown over was made en route by the forestry engineer carried as observer. From September 2 to September 21 thirteen flights were made totalling 20 hours 25 minutes over the Natashquan river, lac Cormier, the St. Margaret's river and along the coastal district as far as the Godbout river. Forestry sketching and preliminary mapping were carried on during all flights and much valuable information was gained as to the topography of the country and of the nature and types of the forest growth.

Flying conditions on the north shore of the St. Lawrence are difficult. There are few sheltered harbours and the weather conditions are uncertain. The immediate neighbourhood of the coast is mountainous with few lakes. Further inland the hills are lower and suitable landing grounds in lakes and rivers are to be found.

On September 21, the objects of the operation having been attained, it was decided to return though conditions were not of the best. There was no room in the sheltered harbour for the machine to take off; a start had, therefore, to be made from the open waters of the gulf. While taxiing to gain flying speed, an exceptionally heavy wave struck the hull of the boat and damaged it considerably. The pilot immediately slowed down and made for shelter. Before it could be beached, the machine sank in shallow water. The crew were taken off by a motor launch and at low tide the engine and other removeable equipment were salvaged. This accident shows the risk attendant on flying along the north

shore of the St. Lawrence and the necessity of providing more seaworthy craft for patrols in such exposed waters. At the same time the success of the expedition proved that the use of aircraft for preliminary reconnaissance in unknown territory, given adequate equipment and proper preparation, is economical and quick. Information, which would otherwise be obtainable only by the equipment of large ground parties, can be obtained with ease and certainty at a minimum cost, both of time and money, by the use of aircraft. The personnel of the expedition returned by boat to Quebec, bringing with them their equipment, notes, photographs, maps and sketches.

Operations closed at Roberval towards the end of October when the ice formed on the lakes in the interior. The machines on the station were dismantled and the engines and gear needing overhaul were shipped to Ottawa Air Station and Camp Borden, where the personnel of the stations will be employed during the winter months on this work.

A translation of the preliminary report to his department by Mr. A. Landry, forest engineer in charge of the work for the Quebec Government, follows:—

PRELIMINARY REPORT REGARDING OPERATIONS AT ROBERVAL AIR STATION, SEASON OF 1922.

To the Chief of Forestry Service,
Forestry Service,
Quebec, P.Q.

SIR.—On June 24 of this year, the Roberval Air Station opened its doors. The machines were quickly erected and the first flight was made on the 29th of the same month.

Climatic conditions, though not always ideal, were, on the whole, favourable. There were periods of bad weather, but, fortunately, they coincided with times when machines were not in good flying condition and our supply of gasoline was exhausted. Autumn, when weather conditions necessitate flying low under a cloud-covered sky, came rather early. Sketching in such conditions is difficult. In the area where we worked, the situation was complicated by the large percentage of dead leaves on the trees of 50 years's growth or less. When the leaves have fallen, it is difficult for the observer to distinguish these growths from the bare ground where new growth is just starting.

The Sub-Station established at Stacker lake this summer was of the utmost service to us. It was situated on a beautiful lake, 65 miles distant from Roberval, as the crow flies. A log camp and tents provided shelter for the staff. We had sufficient equipment to remain for weeks. We generally proceeded to Stacker lake on Sunday evening and returned to Roberval on Saturday evening. Thus one or two machines were left permanently at the Sub-Station, while a second or third travelled with supplies and aerial fuel.

Operations were started at Stacker lake Sub-Station on July 22, and closed—rather hastily, however—on September 23.

I cannot insist too strongly on the advantages of using such a Sub-Station. Situated in the area where our operations were carried out, it extended accordingly the radius of our machines. We are forced to admit, that the H.S. 2L is an old machine, inefficient in many ways, but we were enabled to extend our reconnaissance further north. This would have been impossible had we kept Roberval as our base.

We were thus premitted to take advantage of fine weather which, often, is only of short duration. It also varies in a radius of 60 miles. It might rain at Roberval and shine at Stacker lake. Time and money were thus saved as on each flight we had 130 miles less to cover.

Furthermore, in case of accident, we were always near a base. At the time of our forced landing on August 10 last, the crew would have had to walk 60 miles instead of 25, through forests.

The Roberval Air Station had three objects in view; patrolling, aerial photography and aerial sketching.

Patrolling this year was reduced to its minimum. Fortunately, no fires of any importance occurred in our district. There were settlers' fires which were quickly controlled. Therefore, patrolling was minimized and, for purposes of economy, we arranged that patrolling flights coincided with other forestry work.

On the other hand, aerial photography was carried on on a large scale. The negatives obtained are quite good, and important information will be derived therefrom. 2225 vertical photographs were taken which, in an unbroken length, would represent 600 miles, and cover a surface of 325 miles. We have kept detailed records of all the photographs taken, relating either to their analysis or location.

Only seventy-five oblique photographs were taken, due to the fact that the only oblique photographic apparatus we have at the Station was required for the trip to the north shore of the gulf of St. Lawrence.

We are all aware that for aerial photography, an ideal temperature and a clear sky are required. It is interesting to note that from July 12 to September 19, only 15 days were propitious for aerial photography, and I am convinced that at least 80 per cent of these truly favourable days were utilized for this purpose. The 20 per cent wastage was due to change circumstances.

Most of the flights were made for type sketching and forest reconnaissance. In the lake St. John region our sketches covered an area of about 2,100 square miles, and our reconnaissance covered an area of some 1,300 square miles, that is, we know the nature of the country although none of the lakes were sketched in on the map.

On the north shore, the rivers Natasquan, Pentecote, aux Rochers and St. Marguerite were explored in the same manner. Such operations, however, present greater difficulties and risks, being so far from the base of operations. In fact, Natasquan is 600 miles distant from Roberval, in a straight flying line. The results obtained were, nevertheless, excellent.

In the basin of the Natasquan river, reconnaissance and sketching covered a surface of 3,145 square miles, and this was accomplished in a flight of 7 hours' duration. (If the hourly yield is higher than at lake St. John, it is due to a difference in the method of working.) Exploring was carried out to an extent of 150 miles inland. This shows that with aircraft distances do not count, and it is possible to accomplish quickly work which, with any other methods, would take much longer.

On the rivers Pentecote, aux Rochers and St. Marguerite, the aerial observer detected a recent fire extending over a surface of 600 square miles. The lateness of the season prevented the continuation of work in this part of the country. Weather conditions made returning to the base of operations imperative.

In short, the Roberval Air Station has done good work during the last season and has proven its utility for the advancement of forestry in our country. Neither machines nor personnel remained idle. The seaplanes were flying for 297 hours and 30 minutes, and the co-operation between the flying staff and the forestry observers permitted, in a period of barely over two months, the exploring of 7,145 square miles of land about which we had little or no information, from a forestry point of view.

(Sgd.) ALPHONSE LANDRY,
Forestry Engineer.

QUEBEC, December 10, 1922.

Dartmouth Air Station, N.S.

This station was built by the Department of the Naval Service in 1918 as a base for aircraft engaged in anti-submarine operations on the Nova Scotia coast and for the patrol of incoming and outgoing convoys of troop and store ships, en route to and from Europe, to American and Canadian ports. It is situated on the north shore of the outer harbour of Halifax and provides an excellent base for the operation of aircraft. It is the only seaplane station in Eastern Canada free from ice all the year round. It was transferred to the Air Board in 1920 and has since been used as a repair base for the maintenance of machines used in Eastern Canada. There has been no great demand for flying operations from other Government departments in the Maritime Provinces and consequently few operations have been undertaken. Machines have been flown from the station, however, to Roberval and Ottawa for work during the summer months as required, and it has been the base for combined operations with the Military and Naval Forces, an essential part of Air Force training.

During the fall aerial photography was carried out for the Water Powers Branch, Department of Interior, over the watersheds of the Roseway river, Bear river and East river, Sheet Harbour, and pictures were taken of the Hydro-Electric Development at Musquash and St. Margaret's bay. Satisfactory results were obtained, but owing to the lateness of the season it was not possible to complete the programme, the light being poor for photography and the weather uncertain. The uncompleted work will be finished as early as possible next season when conditions are better.

The station is in command of Squadron Leader A. B. Shearer, and the staff consists of one pilot, one storekeeper, five mechanics and one labourer, making a total, with the officer commanding, of nine persons. This staff is in the nature of a care and maintenance party and, if more flying work is required, will require to be increased. A good storehouse and excellent barrack accommodation exists. On the other hand the hangar is only a temporary building and the slipways and launching platform are of timber, which is fast deteriorating under exposure to the weather. The shop accommodation too is wholly inadequate. If more work is anticipated, expenditures on buildings will be necessary to provide adequate accommodation.

Ottawa Air Station.

This station was opened in the fall of 1920 for the conduct of experimental work in connection with the development of aerial photography, wireless, and other work. A site was chosen, beyond the butts of the Rockliffe Rifle Range, on the Government property, on the south shore of the Ottawa river, where facilities were available for a combined aerodrome and seaplane station. Machines of both types have been flown each season from the station as required. It is the only combined aeroplane and seaplane station in Canada. During the summer of 1922 the station was in charge of Squadron Leader A. E. Godfrey, M.C., A.F.C., and on his being appointed to command the Vancouver Unit in October he was succeeded by Flight Lieutenant C. McEwen, M.C., D.F.C., who returned to Ottawa with his staff from Whitney at the close of the fire patrol operations in the Algonquin Park region.

No permanent buildings have so far been erected on the station and the accommodation consists of a Bessoneau hangar and a small storehouse. The canvas covering of the hangar was replaced in the Spring by wooden sheathing covered with roofing material to give more adequate shelter. Workshop facilities are non-existent at Rockliffe and the station is difficult of access during the winter months. Accommodation for the overhaul and repair of the machines has had to be arranged for elsewhere in the city. During the winter of 1921-22 a building was leased at No. 362 Sparks Street, for this work. A search for more suitable premises during the summer of 1922, resulted in an arrangement being arrived at with the Department of Public Works whereby a part of the space at Victoria Island shipyard was made available. This provides admirable quarters for the work. Machines can be drawn from the water up the existing slipway and dismantled close to the permanent buildings which provide admirable shop, storage and office accommodation where the work can be carried on under excellent conditions. During the winter months the machines can be overhauled and in spring launched down the same slipways and flown direct from the station to wherever they are required. As there is no suitable landing place for flying boats at Borden, a station in eastern Canada to which these may be flown for overhaul and repair is a necessity. Machines from the Whitney operations and equipment from Roberval have been sent to Ottawa Station for repairs and the staffs concentrated there for the work. During the summer any machines requiring extensive overhaul on the Whitney or Parry Sound operations were returned to Ottawa and replaced by machines flown up the Ottawa river from this base. This relieved the personnel of these operations from extensive repair work and obviated the necessity of installing facilities for making such repairs at the temporary bases at Whitney and Parry Sound. The staff of the Station included the officer commanding, one storekeeper, twelve mechanics and four miscellaneous employees, a total of 18.

Operations for photography, transportation, wireless experimental work and other duties, totalling 36 hours and 45 minutes were carried out from the station.

These included oblique photography of the Lievre and Gatineau valleys and the country lying between these rivers for the National Parks Branch, Department of Interior. Experimental work in connection with the development of methods of mapping from oblique photography for the Topographical Survey Branch and flights for Prof. H. L. Cooke in connection with the development of his camera for aerial surveying. The importance of this experimental work is great. Important progress had already been made and a successful conclusion may mean much to those branches of the Government service engaged in the mapping of Canada. Reports of the results obtained up to the present will be found in Appendix No. 1, page 56.

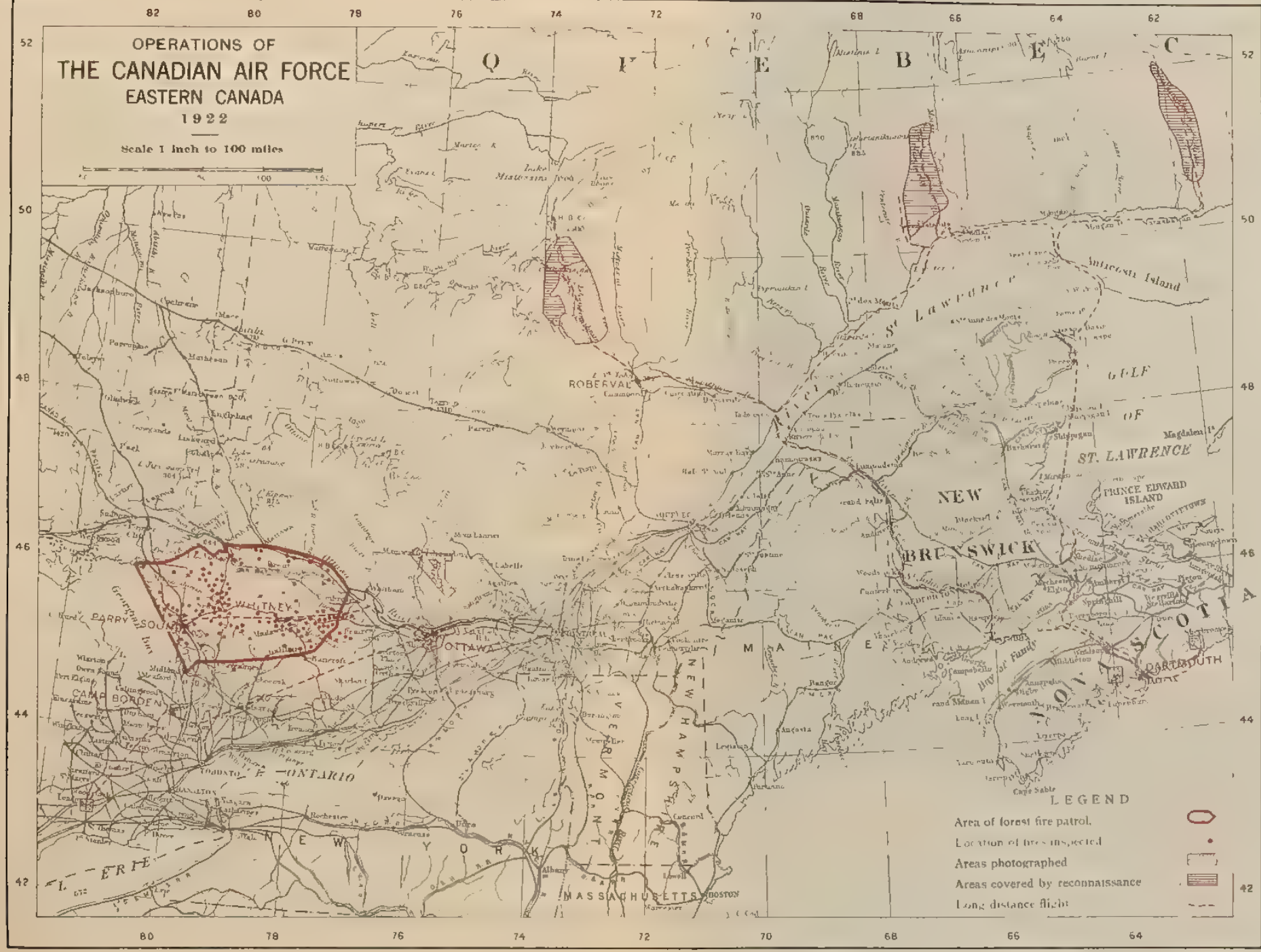
In September, with the co-operation of the Royal Canadian Corps of Signals, a demonstration of the possibilities of using wireless in conjunction with aircraft to increase the efficiency of forest fire patrols was given before a representative gathering of foresters, engineers and lumbermen. Two way communication between the flying boat and the main station representing the district foresters headquarters was established by wireless telephone and conversations passed clearly. Instructions were given from the ground to the machine in the air which were followed with ease and certainty. At a small receiving station some distance away, representing a fire rangers base, speech was clearly audible from the machine flying at a considerable height and distance. This demonstration showed clearly the possibilities of wireless telephony for this purpose and the progress made in its development.

The Investigation of Flying Conditions in the Arctic

In the spring of 1922 the Government decided to despatch an expedition to the Arctic archipelago for the establishment of police posts in the far north and the further exploration of the country. Its administration was under the Northwest Territories Branch, Department of Interior. Mr. J. D. Craig, D.L.S., was placed in charge and the Canadian Government steamer *Arctic* was prepared for the voyage.

The Department of Interior, recognizing the importance of aerial observation in preliminary exploration work and mapping, and the possibilities of establishing inter-communication by air between any posts established, requested the co-operation of the Air Board. After due consideration it was decided to despatch an experienced flying officer, well qualified in meteorology and navigation, to investigate flying conditions in the districts to be visited. It was felt that before information was available on this question it was useless to send machines and equipment. Before any flying could be profitably undertaken, a thorough investigation of the climatic and natural conditions was essential. Squadron Leader R. A. Logan was chosen as specially qualified for this duty. Prior to the war he had been a Dominion Land surveyor and had had experience in Northern Canada. After the Armistice he had made a study of meteorology, aerial navigation and wireless work. His knowledge of these subjects has made it possible for him to investigate to good advantage the different phases of the question and makes his report specially valuable.

The expedition sailed from Quebec on July 18, and returned to the same port on October 2, after visiting the north end of Baffin land, Bylot island, Ellesmere land and North Devon island. Squadron Leader Logan has presented to the Department of Interior a comprehensive report dealing with aviation in the Arctic generally, the uses of aircraft in the far north, the most suitable types to meet the special conditions there and the ground equipment necessary to overcome the difficulties. Questions of transportation, fuel, food, clothing and other supplies, have been inquired into. Much valuable information has been obtained on the climatic and ice conditions in the districts visited and photo-



LITHOGRAPHED BY THE TOPOGRAPHICAL SURVEY OF CANADA, OTTAWA

graphy in the far north. He recommends that, should the Government decide to proceed with the programme of exploration, and if aircraft are judged a necessary part of the equipment, a party consisting of a pilot and two mechanics, with two special small machines and spare parts, should proceed north with the next party sent and should stay a whole year making flights each day when conditions permit, keeping meteorological and other records, observing the flying conditions generally, examining the nature of the landing grounds, and the possibilities of aerial photography throughout the year. A full and comprehensive knowledge of the problem to be solved would thus be obtained with a view to carrying on operations on a larger scale if conditions are found to be, as Squadron Leader Logan confidently anticipates, suitable for the operation of aircraft during a fair proportion of the year.

The problem is a large one and while it would be idle not to recognize the difficulties of operation, there is no doubt that aircraft can facilitate the exploration and mapping of the Arctic. Experience in the settled portions of Canada shows that cold weather in itself is not an insurmountable difficulty. Machines have been operated at Camp Borden and elsewhere continually throughout the year without great difficulty. Just as precautions are required to operate motor cars successfully in cold weather, still greater precautions are needed in the case of aircraft. There is no reason to suppose, however, that when the need arises, with special machines and precautions, aircraft cannot be operated to advantage in the Arctic regions of Canada.

A full report of the work of the expedition will, no doubt, be published in due course by the Department of Interior. The information already gained by Squadron Leader Logan has amply justified his attachment to the expedition and is of considerable value as a preliminary report on aviation in the Arctic. The shortness of the stay in the north naturally detracts from its full value and, until a report can be obtained covering the whole year, the full extent of the problem cannot be determined. Sufficient is known to justify the despatch of a small party with machines to the far north for further investigations, should the Government decide to continue this work.

This completes the review of the operations undertaken during 1922 in conjunction with other Government departments. A summary of these will be found on page 52. It will be seen that great progress has already been made in the development of the practical application of flying in Canada. Flying has brought to the Forestry service a means of transportation and observation which will increase its efficiency very greatly and make possible, in many districts, control of forest conservation which would otherwise be unobtainable.

The developments, during the past year, in the use of aerial photography for exploration and preliminary survey work also show great promise. The Survey services are alive to the importance of the problems. The development of methods of mapping from aerial pictures rests with them. There is little doubt that the lines on which they are now working will be further developed with far-reaching results. Even to-day it is not too much to say that, in unsurveyed country, where there are no great differences of elevation, given geodetic control, that is, points accurately determined at intervals of from thirty to fifty miles apart, the topographical detail of the whole district may be filled in from aerial pictures with a speed and certainty unobtainable by any but the most minute ground surveys. The assistance aircraft can be to surveyors, geologists and others, working in the remoter parts of the country, by providing a rapid, economical and easy method of transportation is proved beyond all reasonable doubt.

What is now required is the provision of aircraft specially built to meet the conditions which obtain in northern Canada. Without such machines little further progress can be made. The types now in use are obsolescent war

machines. Without the aircraft so generously given by the Imperial Government at the close of the war, the work of the past three years would have been impossible. They have given wonderful service. Many of them, after five seasons' constant use, are still fit for much further work, but to obtain the full benefit of the work done, more efficient types are essential. If such machines are available continued progress can be made, without them little further can be accomplished.

On all sides further avenues of work are being opened up. The demand for flying is constantly increasing and as the results obtained become better known and the use of aircraft more familiar, this demand will still further increase.

No country in the world offers greater immediate possibilities for useful flying. Wisely directed, aviation in Canada will become in time a great factor in the development of the country and the conservation of its resources. Air power, like sea power, to be effective and permanent, must be based on a sound economic development for peace uses. On any other basis its maintenance in Canada must be artificial and burdensome in time of peace. The opportunity exists here for sound development as in perhaps no other country. Every effort should be made to assist aviation, not only as a reserve of strength for the C.A.F., but for the advantages its growth will bring to the community as a whole.

STATISTICAL SUMMARY OF CIVIL GOVERNMENT FLYING FOR THE YEAR 1922

Station or Base	Aeros or Seaplanes	Flying commenced	Flying discontinued	Flying period to date (days)	Nature of Flights								Total flights	Total hours flown	Approximate miles flown	Average flight duration (hrs.-min.)	Days on which flying took place
					Forestry reconnaissance, photography and fire protection	Miscellaneous reconnaissance, photography, etc.	Photography	Preventative reconnaissance	Communication, transportation and demonstration	Instructional	Experimental and testing	Miscellaneous or unspecified					
*Vancouver, B.C	S	–	–	365	49	46	16	27	10	5	12	–	176	304·33	18,273	1·09	98
†Halifax, N.S...	S	–	–	365	–	–	3	1	2	3	5	2	16	31·55	1,915	1·59	16
High River, Alta.	A	28–4–22	31–12–22	248	194	49	–	–	3	–	21	–	267	1,075·45	86,045	4·01	206
Victoria Beach, Man.	S	16–5–22	22–10–22	160	125	2	1	–	4	7	18	1	158	324·46	19,486	2·03	77
Roberval, Que..	S	29–6–22	22–10–22	116	87	16	8	–	45	12	19	–	187	297·30	17,850	1·35	93
Ottawa, Ont.....	A S	21–4–22	19–11–22	213	6	18	–	–	30	2	51	–	107	133·32	8,677	1·15	69
Whitney–Parry Sound.	S	23–5–22	3–10–22	134	224	3	–	–	15	–	57	–	299	616·37	40,077	2·03	127
Totals.....	–	–	–	1,601	685	136	28	28	109	29	183	3	1,210	2,784·38	192,323	2·18	686

*Open year round. †Mainly erection and repair base.

X. TECHNICAL AND EQUIPMENT SERVICES

The reorganization of the Technical and Equipment Services of the Air Board from a civil to an Air Force basis has been carried on throughout the year and now is almost complete. Contract and purchasing duties, which, under the Air Board, came under the director of this branch, have now been transferred to the branch of the Director of Contracts, Department of National Defence and consolidated with the other contract work of the department. The storekeeping staff at headquarters and on all stations has been transferred to the

C.A.F. and the technical and designing staffs at Headquarters enlisted or granted commissions in the C.A.F. Wing Commander Stedman, previously Director of Technical Services and Stores, was appointed Assistant Director of the C.A.F. in charge of these duties. All work in connection with the supply, care and maintenance of equipment and other storekeeping duties on all stations and the responsibility for the conduct of the workshops at Camp Borden and elsewhere rests with him. Designs for new machines, the preparation of specifications for their purchase, the modification of existing machines and similar work is under his supervision. A short synopsis of the work of the Technical and Stores Sections and the research carried out by the Associate Committee on Air Research of the National Advisory Committee on Industrial and Scientific Research is as follows:—

Technical Section.

This section has been charged with:—

1. Engineering calculations to determine the strength of construction and stability of commercial aircraft with a view to determining whether they are suitable for Certificates of Airworthiness.

2. The issue of modifications necessary for bringing commercial machines up to the required standard for airworthiness, the standard adopted for a Certificate of Airworthiness in Canada being the same as that adopted in Great Britain.

3. The preparation of specifications for materials used in aircraft and the adoption of British Engineering Standard specifications to meet Canadian conditions. This work has in most cases been carried on in conjunction with the Canadian Engineering Standard Association.

4. The inspection and testing of materials purchased by the Air Board for use at Air Stations and of materials proposed by commercial companies for use in commercial aircraft. In all cases these tests are carried out to determine whether the materials are in accordance with the Canadian Air Force specifications.

5. The preparation of detailed specifications for flying boats and aeroplanes required for use under Canadian conditions.

6. The preparation of designs for converting a standard training machine into a single float seaplane with a stationary engine.

7. Examination of aircraft and engines and the issue of drawings and memoranda dealing with defects, modifications, repairs, etc.

8. Preparation of designs and the issue of drawings relating to aircraft accessories, such as camera mounts, etc.

The repair and overhaul of the engines and machines is as far as possible being concentrated in the shops at Camp Borden. Engines are being returned from outside stations and the mechanics necessary for the overhaul work are concentrated there during the winter months where workshop facilities exist. The construction of spare parts required and modification of a number of machines is being undertaken this winter. Six Avro machines are being fitted with single floats and are being modified to take the Hispano-Suiza engine of 180 horse-power, in place of the 130 horse-power Clerget rotary engine, for use as forest fire-patrol machines.

Early in the year steps were taken to establish an aircraft inspection department separate from the control of the work in the shops. The necessity for the most minute and particular inspection in regard to material and workmanship on aircraft and engine parts is evident. Inspection to determine that

the quality of materials, standards of construction and strength are up to specification is vitally important. An independent inspection department by which a check on this work can be maintained is essential. As the aircraft industry grows in the country its necessity will increase, as before airworthiness certificates can be granted, every precaution must be taken to determine that the machine fulfills the necessary conditions laid down to ensure its safety in the air. This branch will provide the facilities for making the necessary tests and inspections and should become in time a valuable asset to the aircraft industry as a bureau to which questions of difficulty or doubt may be referred for investigation. It will make possible uniform inspection of aircraft throughout the country and render the standardization of machines and parts for quality and strength possible.

Stores Section.

During the past year the most important work carried out in this Section has been the complete change of the accounting procedure for all stores in order to conform to the procedure used in the Royal Air Force. This change of procedure has now been completed.

An audit of all storekeeping accounts at the various Stations has been carried out.

Instructions on care and maintenance of different classes of aircraft stores have been issued to all Stations.

Research.

Following the procedure of previous years, the Associate Air Research Committee, which works under the direction of the Advisory Council for Scientific and Industrial Research, has continued to consider problems that have been presented to it by the Air Board. The work has mainly been carried out in connection with flying under conditions which are peculiar to Canada, that is, winter flying. The results obtained have been communicated to commercial firms and other interested bodies unless they have been of a confidential nature.

The following researches have been continued:—

1. The operation of aero engines at low temperatures by Professor Robb at the University of Alberta, where very interesting results on running an aero engine under low temperature conditions have been obtained.

2. Mr. Stanley Smith, of the Topographical Survey Branch, has continued his experiments on barograph diaphragms.

3. Professor McKergow, of McGill University, has continued his work on anti-freeze mixtures.

4. Professor Parkin, of the University of Toronto, has carried out a number of tests in the wind tunnel.

5. Mr. Gliddon, of McGill University, has carried out some experiments on the friction of runners on snow.

6. Professor Bain, of Toronto University, has carried out tests on the storage of oil under low temperature conditions.

7. Professor Gillespie, of Toronto University, has carried out tests on low temperature effects on aeroplane rigging.

Most of the researches referred to are still continuing. Various questions are referred to these gentlemen as the necessity occurs, and it is to be remarked that they all work in an honorary capacity.

Alterations in the laboratory of the mechanical engineering faculty of the University of Toronto, has made the operation of the only Wind Channel in Canada no longer possible. This channel was built during the war by the

Imperial Government and was available for testing, research and experimental work, not only by the University, but also the Associate Air Research Committee and the Air Board. The maintenance of facilities for such work is essential to progress in aeronautics. Negotiations were therefore entered into with the university authorities and the Air Research Committee with a view to re-establishing them. An agreement has been reached whereby the University will continue to maintain the channel, operate it, and make it available at any time for the work of the Canadian Air Force and the Air Research Committee, if the Government provide $5,000 towards the erection of a new building in which to house it. A vote of this amount was included in the supplementary estimates for 1922-23 and approved by Parliament. Arrangements have been made by the university authorities for the erection of a suitable building at a cost of approximately $6,500. The $5,000 voted by Parliament will be available to meet part of this expenditure.

The loss of these facilities would have been a great blow to the progress of aviation in this country and would have left Canada without facilities to continue researches on conditions peculiar to this country and would have prevented the carrying out of practical tests and experimental work of the greatest importance to the development of the aviation industry.

CONCLUSION

This completes the review of the work of the Air Board for 1922. It would be incomplete without a tribute to the energy and efficiency of the officers, men and employees of all classes who have made this record possible.

The year has been one of doubt and uncertainty as to the future, inevitable during a period of reorganization. Most of the work in the field has been done from temporary bases, without permanent or adequate facilities. The aircraft available are obsolescent and in many cases of types unsuitable for the work in hand.

To have achieved so much under these circumstances is a happy augury for the future and a proof of the high morale and esprit de corps of the service.

APPENDIX No. 1

Through the courtesy of Dr. E. Deville, LL.D., D.T.S., Director General of Surveys, the following report on aerial operations during 1922 is published, together with two appendices:—

(*a*) "Plotting topography from oblique aerial photographs" by the Topographical Surveys Branch, Department of the Interior, and

(*b*) "Experimental topographical survey from the air" by Prof. H. L. Cooke, of Princeton University.

Progress in the development of methods of survey from the air in this country owe much to the interest and assistance of Dr. Deville. Through his guidance and advice substantial progress has been made in this science which is of the greatest importance to Canada where vast areas still remain to be mapped.

AERIAL PHOTOGRAPHIC OPERATIONS, 1922

The use of aerial photographs in making topographic maps is a subject of great interest and much investigation throughout the world; to the Dominion of Canada, where such large areas of unmapped country exist, the development of this science is of vital importance.

During the season 1922 the Topographical Surveys Branch carried on experiments in the utilization of aerial photographs in connection with their regular work. At their request, the Air Board of Canada made numerous flights, taking vertical photographs at altitudes of from 5,000 to 11,000 feet, and oblique photographs at lower altitudes, using cameras equipped with lenses of 12-inch focus. Vertical photographs were taken in connection with the revision of sectional sheets and also along the Manitoba-Ontario interprovincial boundary. Oblique photographs were taken chiefly in northern Manitoba for the purpose of determining their utility for filling in detail in connection with the traverses of northern waters. The Air Board also made reconnaissance flights with officers of the Branch in northern Manitoba and in the Jasper Park area.

At the request of the Topographical Surveys Branch vertical photographs were taken by the Air Board during the season 1922 in the following locations:

(1) Along the Belly river, Alberta, from the north boundary of township 1-28-4 to the north boundary of township 8-24-4, a distance of about 52 miles.

(2) Along the Waterton river from the north boundary of township 3-28-5 to the north boundary of township 6-25-4, photographs having been previously taken for the International Joint Commission of the Waterton lakes area and extending along the Waterton river northerly to the north boundary of township 3-28-5 and prints of these were furnished. The total length of strip photographed along these lakes and river is about 54 miles.

(3) Along the St. Mary river from the north boundary of township 1-25-5 northerly to its junction with the Belly river and thence up Belly river to north boundary of township 8-22-5, a distance of about 54 miles. Photographs had previously been taken for the International Joint Commission extending from the north boundary of township 1-25-5 southerly along St. Mary river to the southerly end of St. Mary lakes in United States, a further distance of about 36 miles.

(4) Along the Bow river, Alberta, extending from Calgary to the west boundary of township 24-8-5 a distance of about 50 miles, and also through the town of Banff.

(5) Along the Interprovincial Ontario-Manitoba Boundary from Mileage 59·5 to Mileage 96.

(6) Along the Milk river through township 2, ranges 28, 27, and part of 26, west of the Fifth meridian. Photographs had previously been taken for the International Joint Commission extending from the junction of the north and south branches of the Milk river southwesterly along both branches to the U.S. boundary, and prints of these were supplied.

(7) About 200 square miles was vertically photographed of Moose Mountain forest reserve, Saskatchewan, in townships 9, 10, 11, ranges 2, 3, 4 and 5, west of Second meridian and township 12-5-2.

(8) About 50 square miles of Rocky Mountain forest reserve was vertically photographed in townships 28, 29 and 30, range 7, west of the Fifth meridian.

Oblique aerial photographs were taken by the Air Board for experimental use in the Topographical Surveys Branch in the vicinity of Ottawa, in northern Manitoba near Pelican Narrows, Cranberry lake and Berens river. A number were also taken in the Moose Mountain Forest Reserve.

The Topographical Surveys Branch have mounted in mosaic form the areas photographed for them and for the International Joint Commission along the Belly river, Waterton river and Waterton lakes, St. Mary's river, Bow river, Manitoba and Ontario Boundary, Rocky Mountain Forest Reserve and Moose Mountain Forest Reserve. The mosaics were mounted in strips extending across a township and oriented by the control available. The control consists generally of section lines shown on the prints or of river traverses. The section lines are added to the mosaic and protographic reductions have been made of the Belly river series, the Manitoba-Ontario boundary series and the Bow river series while other reductions are in progress. The reduction is made to the scale of the regular township map, thus facilitating the transferring of corrections and additional information, and, in getting the reduction factor, the height of the plane was assumed constant across a township. In the Moose Mountain Forest Reserve area, the numerous unmapped small lakes were transferred directly from the strips of photographs to the working plans by pantograph, the scale and orientation of the prints being determined by the control shown thereon.

At the request of the Reclamation Service prints of their photographs, vertical and oblique, are being located, oriented and mounted in the office of the Topographical Surveys Branch.

When the experimental oblique photographs were taken the positions of the principal points and the focal lengths of the cameras used were not accurately known and a number of these prints were plotted by graphical methods using four control points and not the camera constants. The constants of the six cameras used by the Air Board were later determined at the Topographical Surveys laboratory and graphical methods of plotting were then used which involved these constants and enabled plotting to be done with three control points or two control points with horizon line showing. The latter method of plotting due to Dr. Deville is explained in Report A.

Oblique photographs taken along the course of a control traverse made by the Topographical Surveys Branch last year were plotted graphically, using the method requiring two control points and the horizon line. The photographs were taken at altitudes of from 1,500 to 2,400 feet. The resulting plans made from the photographs compared favourably with the traverse plan and supplied further detail of the areas viewed. The area which can be accurately plotted from one print can be increased greatly by higher flying, provided the visibility is not impaired. A light filter and the use of panchromatic films will no doubt eliminate to some extent the haze which often conceals or dims the apparent horizon line. With the cameras in use at present a photo-

graph taken at an altitude of say 10,000 feet which shows the horizon line would not show the area extending from a point vertically below the aeroplane outward for a distance of about three miles. This is remedied on a new camera planned by Dr. Deville which is composed of four lenses whose principal axes lie in one plane and are inclined to each other in this plane at definite angles. When this camera is suspended from an aeroplane at right angles to its line of flight, the terrain from horizon to horizon is photographed. Should the plane bank while photographing, a horizon line will still show in one photograph by which the direction and extent of tilt can be determined for use in plotting the set of photographs.

With two control points in the same horizontal plane in the lapped area, taken preferably near the plane, it will be possible with this camera to plot a large field. The lapped areas on each side will be large and here displacements due to elevations away from the ground plumb point would be corrected from the two views by noting the intersections of the lines joining the plotted positions to the respective ground plumb points.

The Topographical Surveys Branch have not at present any instruments to facilitate plotting from aerial photographs so all experimenting is in connection with graphical methods.

To date approximately 2,000 prints 7 inches by $8\frac{1}{2}$ inches have been received from the Air Board for use in the Topographical Surveys Branch.

At the request of the Surveyor General, the Air Board made a series of experiments on a camera and system of survey invented by Mr. H. L. Cooke, Professor of Physics at Princeton University. The experiments have not yet been finally concluded but the results so far are very encouraging. A full description of the camera and method of surveying is given in Report B.

REPORT A

Plotting Topography from Oblique Aeroplane Photographs

The settled part of Canada, of which more or less imperfect maps are available, is confined to a fringe or belt along the southern boundary. The northern part, of immense extent, is very little known. Roads do not exist, the only means of communication being by dog train in winter and by the lakes and rivers in summer. Traverses along the waterways furnish the basis for such maps as we have. In the best of these traverses, the angles are measured with a theodolite and the distances by stadia or with a range finder. The surveyor completes his plan by sketching such details as he can see from the level of the water; what is beyond the shores or the islands is necessarily omitted.

The details of the topography are plainly visible for several miles on an oblique photograph taken from an aeroplane. If the angle of depression is not too great, the horizon appears as a straight line across the photograph. Differences of elevation in the western provinces do not generally exceed a few hundred feet. The horizon seen from an aeroplane at an altitude of 2,000 feet is 60 miles away at which distance an elevation of 100 feet subtends roughly an angle of one minute. For the purpose of plotting an exploration from photographs taken at altitudes of 10,000 feet or thereabouts, such differences of elevation as occur in the western provinces may therefore be ignored and the horizon line on the photographs may be treated as if it were the horizon of the sea.

The traverse is plotted on cross section paper, fig. 4, one set of lines being due north and south, and the other set east and west. The lines are twenty chains apart, each square mile being divided into sixteen small squares. *A* and *B* are two stations of the traverse. These two stations are visible on an aero-

plane photograph, fig. 5, which shows also the apparent horizon. The focal length and the principal point of the photograph have been determined and are known: it is now proposed to draw on the photograph the perspective of the lines of the cross section paper.

The first step is to correct for dip the horizontal line of the photograph. This correction expressed in millimetres is:

$$c = \cdot 0023 f \sqrt{h}$$

where c is the correction and f the focal length, both in millimetres and h the altitude of the aeroplane in chains. An approximate altitude is employed for calculating the correction and the true horizon is drawn on the photograph parallel to and above the apparent horizon at a distance equal to the correction. Unless the estimated altitude is very much in error, the correction calculated as above is sufficiently accurate, otherwise a new value of the altitude derived from the following constructions will have to be employed and the constructions made over anew.

The process adopted for the solution of the problem consists in drawing a side elevation, a front elevation and a projection on the ground plane.

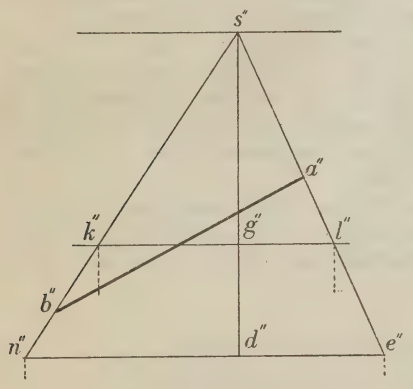


Fig.1 Front Elevation

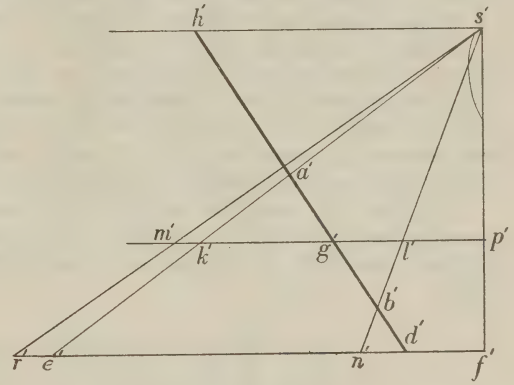


Fig.2 Side Elevation

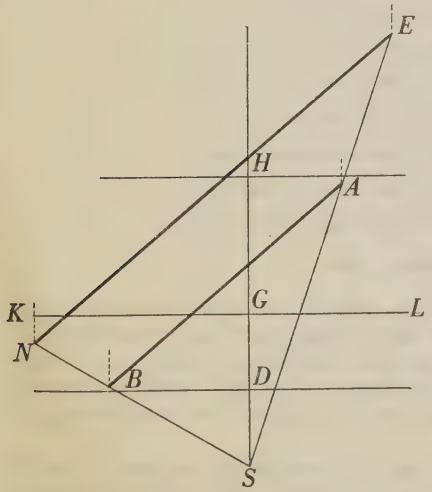


Fig.3 Ground Plane

Let s', fig. 2, be the position of the areoplane, $s'\ h'$ the trace of the horizon plane and $s'\ f'$ the vertical of the station. By means of the focal length and the true horizon, draw the trace $h'\ d'$ of the plane of the photograph. On the scale of the survey plotting plan, take $s'\ f'$ equal to the approximate altitude of the aeroplane and draw the trace $f'\ r'$ of the assumed ground plane. Make $h'\ a'$ and $h'\ b'$ equal to the distances of A and B, fig. 5, from the true horizon, join $s'\ a'$ and $s'\ b'$, fig. 2, and produce to the intersection of the assumed ground plane in e' and n'.

For the front elevation, fig. 1, let s'' be the position of the areoplane and $s''\ d''$ the principal line. From measurements on the photograph, plot the projections a'' and b'' of A and B, join $s''\ a''$ and $s''\ b''$ and produce to the intersection of the assumed ground plane in e'' and n''.

For the ground plane, fig. 3, let SH be the projection of the line of sight, and S the projection of the station. Make SD equal to $f'\ d'$ and SH equal to $s'\ h'$: through H and D draw the projection of the horizon line and the trace of the plane of the photograph by the assumed ground plane. By means of their front and side projections, plot the line EN which should, if the altitude were correct, be equal to AB of the plotting plan. Generally it will be different and the ground plane has to be moved up or down till equality is obtained.

Make $f'\ r'$, fig. 2, equal to EN, join $s'\ r'$, and between $s'\ r'$ and $s'\ f'$ insert a line $p'\ m'$ parallel to $f'\ r'$ and equal to AB, fig. 4. The line $p'\ m'$ is the trace of the true ground plane. Produce it across fig. 1. On the ground plane, fig. 3, make SG equal to $p'\ g'$ and draw the true ground line KL. Plot the line AB from the new intersections l', k', l'' and k'' with the true ground line. As a check, the lines EA and NB produced must intersect at S.

The line SH and the points, S, G, and H are now transferred from the ground plane to the plotting plan. The projection of the horizon line $V_1\ V_2$ and the trace LK of the plane of the photograph are drawn at right angles to SH.

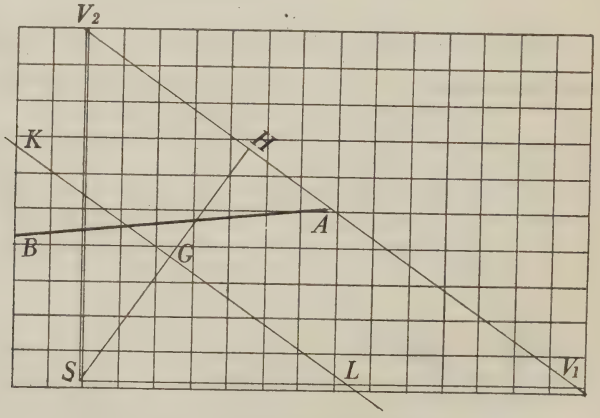


Fig.4 Survey Plotting Plan

Through S, fig. 4, draw the parallels SV_1, and SV_2 to the lines of the grid to their intersection with the projection of the horizon line and transfer them to V_1 and V_2 of the photograph: these are the vanishing points of the perspective of the grid. The intersections of the lines of the grid with the ground line LK, fig. 4, are taken from the plotting plan, transferred to the photograph and joined to the vanishing points.

It is obvious that the scales employed for the constructions can be varied to suit. If one of the vanishing points is too far away, the lines of the grid perspective can be drawn with a centrolinead.

Gridded Photograph.

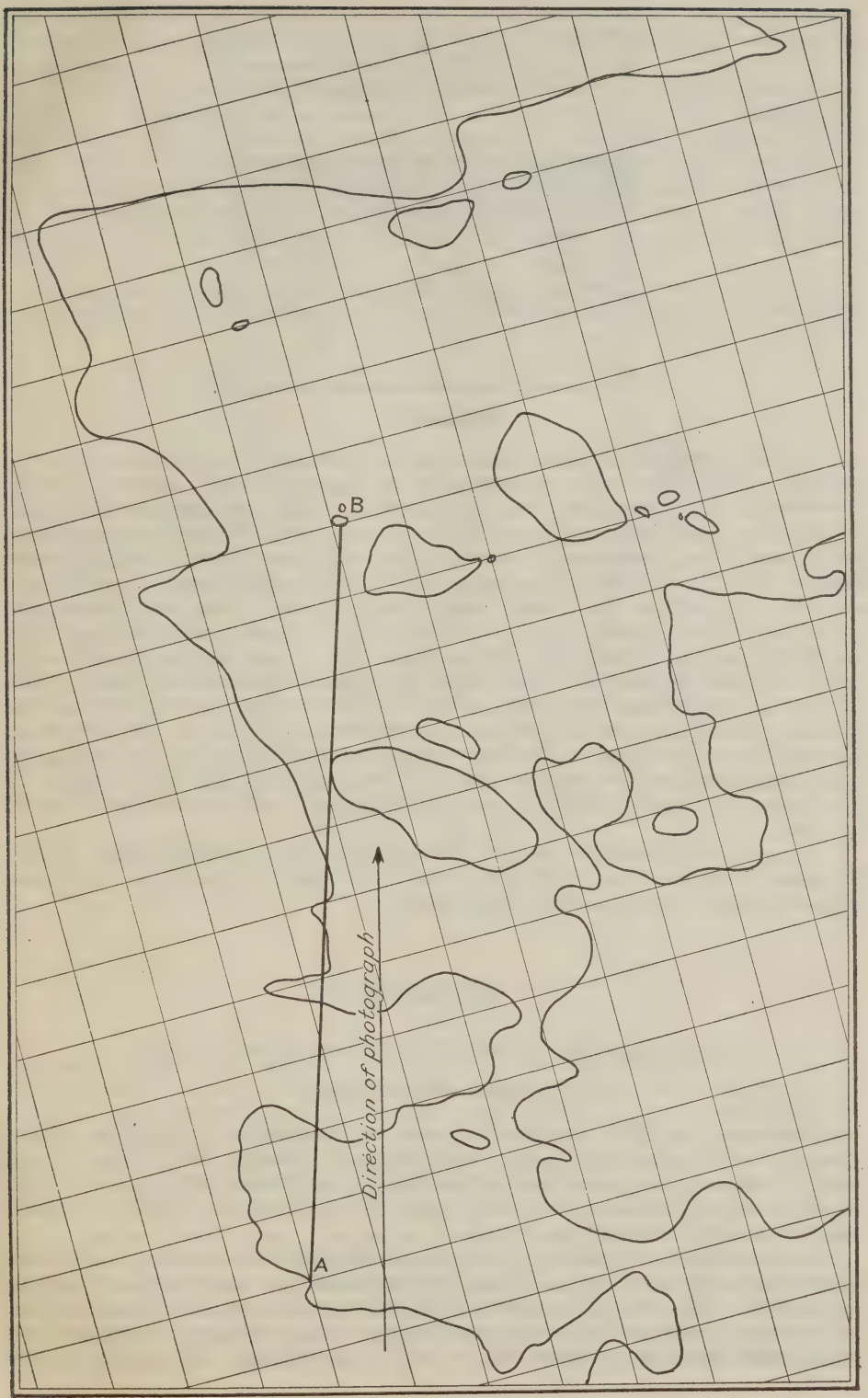
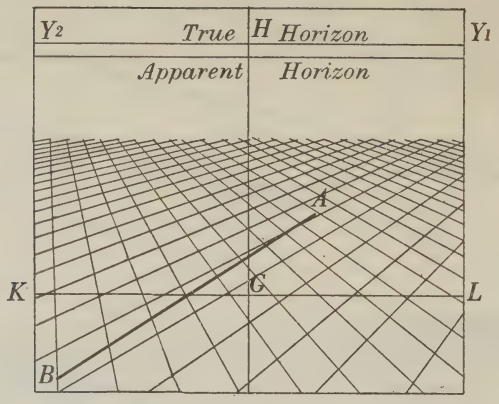


Fig. 7.—Plan plotted from opposite photograph.



Photograph

Another method has been resorted to for plotting from photographs of the western prairies when such photographs are taken with the camera pointing downwards. The townships are subdivided into sections by lines one mile apart running due north and south and due east and west. Roads are established and opened along a number of the section lines and show distinctly on the photographs. If all the section lines were visible, they would form a perfect grid over the photograph and would require nothing more than subdivision into smaller squares for plotting from. Generally, however, only a few of these lines are visible on the photograph, but provided two of these are north and south roads and two are east and west roads, the missing lines can be drawn. This is done by producing the visible roads to their intersections which are the vanishing points from which the missing lines are to be drawn. The separation of these lines is obtained by drawing a front line, parallel to the line joining the vanishing points, and measuring upon it the separation of the visible roads. In most cases the vanishing points are very far away and a centrolinead has to be used.

Instead of drawing the lines of the grid from the vanishing points, it may be more convenient to draw two front lines and to space the grid lines proportionately upon these two front lines.

REPORT B

Experimental Topographical Survey from the Air

By Prof. H. L. Cooke.

Since early in 1920, experiments have been in progress designed to develop a method of topographical survey with aeroplane photographs. These experiments, which are now approaching completion, are being carried out by Professor Cooke of Princeton University with the co-operation of the Air Board and the Geodetic Survey Department.

The circumstances which led to these experiments were as follows: Professor Cooke had devised a method of producing contoured maps from overlapping photographs and tested this method with photographs of a collection of well defined points arranged in an irregular manner in a courtyard, the photographs being taken from the windows of the adjoining building. The results of this

experiment showed that the method was geometrically sound and that elevations as well as positions could be determined from photographs secured in this manner.

In the late spring of 1920, Professor Cooke wrote to the Surveyor General, Dr. Deville, explaining that he was anxious to carry out experiments with photographs taken from aeroplanes and suggesting that he would be willing to undertake work of this sort with the co-operation of the Canadian Government. After a visit to Princeton and an examination of the method, Dr. Deville proposed to the Air Board that experiments of this character should be taken in hand. This was agreed to by the Air Board and the work has been in progress since that time.

The general theory upon which this method of contour surveying is based may be understood by reference to figure 1. *ABC* are three objects whose posi-

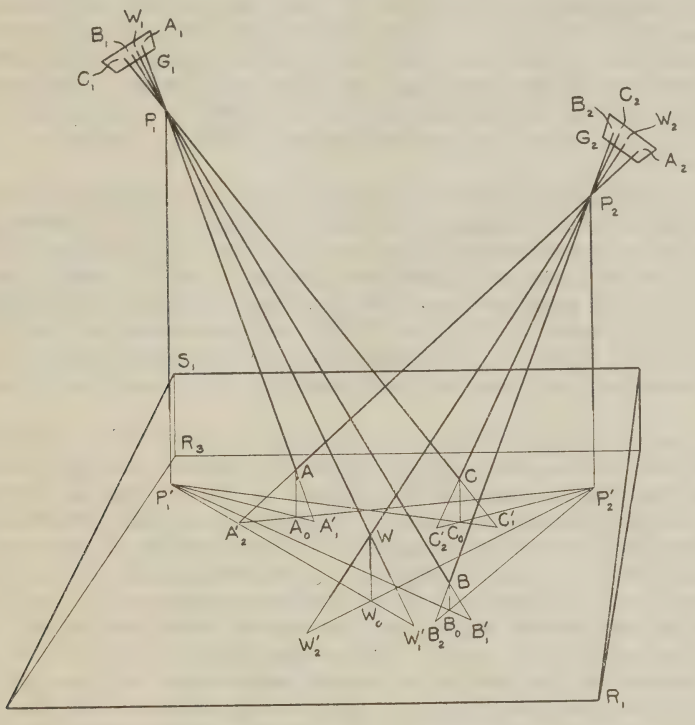


FIG 1

tions and elevations are known. W is an object of which the position and elevation is to be determined. R_1, R_2 represent a datum plane such as sea level and R_1 S_1 is the plane including the known positions ABC. Rays from ABC pass through photographic lens at P_1 and form images $A_1B_1C_1$ and W_1 on the photographic plate G_1, P_1 and G_1 composing the photographic camera in the aeroplane. In the same way the rays from ABC and W form images $A_2B_2C_2W_2$ on the plate G_2, exposed from the position P_2. It is necessary that photographs should overlap in the terrain including known points and the unknown object W. Suppose that the plate G_1 is mounted in projection apparatus in which the projection lens occupies the same position relative to the plate that P_1 occupies relative to G_1. When an image of the plate G_1 is projected under these conditions, the rays forming images of $A_1B_1C_1W_1$ will form the same mutual angles as the rays passing from $ABCW$ to P_1 at the time the photograph was exposed

from aeroplane. Suppose now that three points are plotted to scale on a projection screen to form a triangle similar to the triangle ABC in the plane R_1S_1, and suppose that by means of suitable apparatus the images of $A_1B_1C_1$ are made to fall into coincidence with the plotted points of the triangle on the screen. Under certain restrictions, which have been shown to occasion no difficulty in practice, the projection lens, when this coincidence has been effected, will occupy a position relative to the plotted points ABC similar to the configuration P_1ABC in nature at the time the photograph was exposed. If, after this coincidence has been effected the projection screen be rotated from the plane corresponding to R_1S_1 to a plane corresponding to R_1R_3, and if the projected image of the plate be then photographed on the screen surface, images corresponding to $A_1'B_1'C_1'W_1'$ will be formed on the plate. And suppose that P_1', the projection of P_1 on the screen, can be ascertained by some suitable means. The plate on which the photographic projection of G_1 has been recorded will then show the configuration $P_1'A_1'B_1'C_1'W_1'$. The plate G_2 is then similarly placed in projection apparatus, coincidences with the plotted position ABC obtained, the screen rotated through the same angle as before, and a second photographic plate has recorded upon it the positions $P_2'A_2'B_2'C_2'W_2'$. The heights $P_1'P_1$ and $P_2'P_2$ to the same scale as to plotted triangle ABC are determined by suitable means.

The two photographic plates on which these projections have been recorded are then transferred to a surface on which the map is to be drawn, the plates occupying the same relation as that shown in figure 1 on the plane R_1R_3. It is obvious that under these conditions lines joining P_1' to W_1' and P_2' to W_2' will intersect in W_0 the map position of W, and that the radial distortions W_0W_1' multiplied by the ratio of $P_1'P_1$ to $P_1'W_1'$ will determine the height W_0W of the undetermined object W. Apparatus has been designed and constructed to carry out processes analogous to those described, in a rapid and accurate manner.

There are two main difficulties in carrying out this kind of procedure. The first one is that the simplest way to obtain overlapping photographs is to have the axis of the camera considerably inclined to the vertical at the moment of exposure, so that obliques are obtained. Photographs of this type when projected on an oblique surface are not completely in focus unless the projection lens is swung on its center. If this swinging or decentering of the lens is resorted to, certain errors are introduced into the projection, and geometrical and mechanical difficulties are encountered which occasion serious complications and materially reduce the accuracy of the work. The second difficulty is that the position of P_1 as determined by the method of optical coincidence with the plotted points is ambiguous, as there are always at least two positions of the projection lens from which complete coincidence can be effected. In practice, this ambiguity has been found to occasion no trouble provided certain precautions are observed which need not be dealt with in detail here.

The experiments which have been carried out at Ottawa with the co-operation of the Air Board have had for their object the development of a type of aerial camera adapted to secure wide angle vertical photographs from aircraft in flight. It may be seen readily that photographs of this type may be made to overlap common territory while the axis of the camera is maintained substantially vertical and that when they are projected on the screen surface as described above, the screen will be approximately normal to the axis of the projection camera, so that the image on the projection screen may be brought into satisfactory sharp focus without having to resort to decentering of the lens. A second and very important advantage of the wide angle vertical photograph is the fact that a large area is covered with a single exposure. A third advantage is the fact that if a given area is to be covered by a single vertical photo-

Fig. 2.—Photograph taken with Prof. H. L. Cooke's camera.
The original negative is ten inches diameter: it was reduced one half for reproduction.
The stretch covered is 3½ miles wide and the photograph takes in about 9·5 square miles.
The height of the aeroplane was about 10,000 feet. The lens was a Steinheil Oethostigmat of 150 m/m focus used at 7/12 and the exposure was about 1/3 second.

graph to be used for contour surveying, the closer to the ground the aeroplane is flying at the time of exposure the better. This follows from the fact that the rays forming the marginal portions of the image on the plate are more oblique, so that the radial distortion corresponding to W_0W_1' (Fig. 1) will be increased, leading to greater accuracy in the determination of elevations without any corresponding decrease in the accuracy of locations.

Two different kinds of camera designed with this object in view have been tested at Ottawa. At the present time it is not advisable to give any detailed description of these cameras, as they are the subject of pending patents. The first type of camera, experimented with in the summer of 1921, shows that in principle it was a practical and satisfactory type of instrument. The lens employed was a Steinheil Orthostigmat Series E, F:12, 150 mm. focus, working in conjunction with a circular photographic plate of 11 inches diameter. The photographs were exposed from a height of 10,000 feet, the image covering an area of a trifle over nine square miles for each plate. Of this area about seven square miles are covered with sufficiently sharp definition to be employed satisfactorily for surveying purposes. The failure of the image on the outer portions of the plate is due mainly to the lens itself, as photographs exposed on the ground show a similar fuzziness at the edge. An example of one of these aeroplane photographs is shown in figure 2. The illumination falls off somewhat rapidly towards the edge of the circle. This is partially due to the usual cause of this effect in photographic lenses but is also in a large measure due to the fact that the exposures were made through a plate glass window in the bottom of the aeroplane, so that the oblique rays suffered a serious proportional loss by reflection at the glass surface. Fifteen of these photographs cover an area of approximately fifteen square miles with a very heavy overlapping and these plates are being employed to produce a contoured map of the region. The duration of exposure of all these photographs was approximately one-third second, this being necessitated by the fact that the plates were exposed in September when the light is not very strong in the latitude of Ottawa. The approximate scale of the photographs 1:20,000 is somewhat small, but seems quite satisfactory for experimental purposes.

During the winter of 1921 to 1922 a second camera was constructed, designed to cover a considerably wider field of view. Tests on this camera were carried out in September, 1922. The resulting photographs although good in the centre showed a very rapid falling off in definition away from the centre. This appears to be due to two causes. First, the atmospheric conditions were not good for photographic work at the time when exposures were made, the effect of haze on the oblique portions of the plate being very serious, so that the outer edges of the plate show very little trace of image. The use of a suitable ray filter will reduce this difficulty. The second cause of the failure of the definition away from the centre of the plate appears to be due to certain imperfections in the adjustment of the mechanism. This difficulty was realized before the experimental tests but as the flying season was near its close, there was not time to rectify the matter. It is hoped that later tests on this camera will show that it is considerably superior to the first type employed. The lens employed in the second type of camera was a Goerz Hypergon, F:22, 75 mm. eq. foc. working on circular photographic plate of 12 inches diameter. Exposures of one second were employed. It is hoped in a later report to give a detailed description of the theory and construction of these two cameras.

The aeroplane employed in these tests was a DH4B furnished by the Air Board, alterations in the observer's cockpit being made for the installation of the cameras.

As stated above, fifteen of the plates exposed during the summer of 1921 with the first type of camera are being employed for the purpose of preparing a

contoured map of a region of about fifteen square miles. This region is about ten miles NNW. Ottawa, in the neighbourhood of Kingsmere lake, this country being chosen as showing the greatest variation in elevation in the vicinity of Ottawa and as presenting the most serious difficulties in an aerial survey, a very large proportion of the area being covered with densely wooded slopes. The control points employed for these fifteen photographs are seven in number, arranged roughly in the form of a hexagon with one point at the centre, the lengths of the side of the resulting six triangles averaged about two miles. The variations in level of the control points amount to 195 metres. The planes of the six control triangles are all tilted out of the horizontal through dihedral angles ranging between 2° 04′ and 3° 48′.

Apparatus for utilizing these plates for survey purposes has been constructed at the Palmer Physical Laboratory of Princeton University. This apparatus consists of two main parts; the first being a rectifying camera and screen designed to secure optical coincidences of the images of the control points and subsequently to secure horizontalized projections, as already explained in dealing with the general theory of the method. The second part of the apparatus is designed to locate projected images of the horizontalized projections on a mapping surface in their correct relation as shown diametrically in the plane R_1R_3 (Fig. 1.)

Two views of the rectifying apparatus are shown in figures 3 and 4. This consists essentially of two parts, the camera proper and the projection screen. The body 1 of the projection camera is the body of the first type of aeroplane camera employed in the tests at Ottawa. This is supported rigidly in a U-shaped casting 2 with a source of illuminations in a disk shaped box 3 secured to the same casting. The projection lens employed is the same type as that utilized in exposing the plates from the aeroplane but of half the focal length, namely 75mm. It is rigidly mounted on the camera front with its axis and inner principal points in the same position relative to the plate as the position of the axis and inner principal point of photographic lens employed for the exposures. This causes the rays passing out through the outer principal point of the projection lens to make with each other the mutual angles demanded by the theory of the method.

The U-shaped casting 2 is pivoted on the axis 4-4 and is sustained by the bearings 5 within the fork shaped casting 6. This casting 6 has a shank 6′ which rests in bearings in the heavy casting 7, so that it may be rotated about the horizontal axis 8-8. The casting 7 is slidingly supported on horizontal bars 9 arranged parallel to the axis 8-8 so that the camera and its supporting mechanism may be made to move backwards and forwards parallel to 8-8. The horizontal bars 9 are supported by means of the standard 10 on the base casting 11. The screen 12, supported in a rectangular metal frame 13, is rotatably mounted about the horizontal screen axis 14-14 which intersects with the axis 8-8 at a point on the surface on the screen. The U-shaped casting 15 supporting the frame 13 is mounted on the rotating table 16 of a 6″ T. & S. theodolite and is so arranged that the vertical axis of rotation of this theodolite stand passes through the point of intersection of the axes 8-8 and 14-14, this point of common intersection of the three axes being termed the screen centre. The theodolite base is rigidly mounted on the base casting 11. The axis 4-4 is arranged to intersect with the axis 8-8. The photographic plate to be projected is mounted on a circular plate holder 17 which is arranged to rotate about an axis normal to the plane of the photographic plate and passing through the intersection of the axes 4-4 and 8-8, this common point of intersection of the three axes coinciding with the forward principal point of the projection lens. The rear principal point of the projection lens is arranged at the same point relative to the photographic plate that the rear principal point of the photographic lens occupied at the time

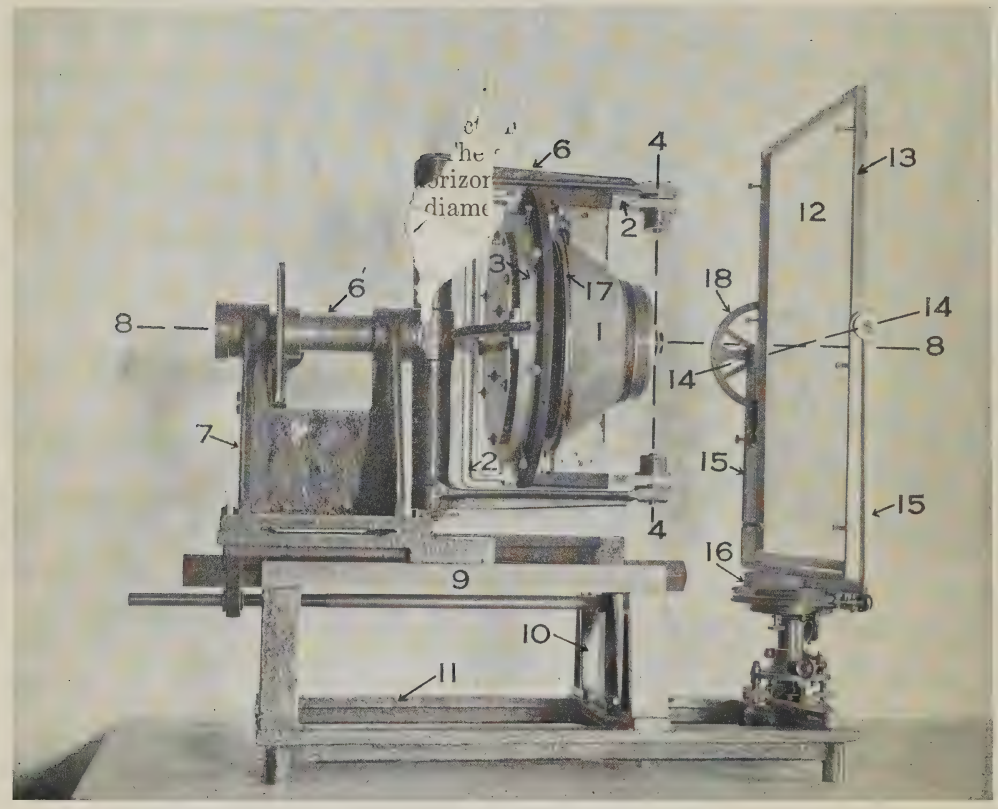


Fig. 3.

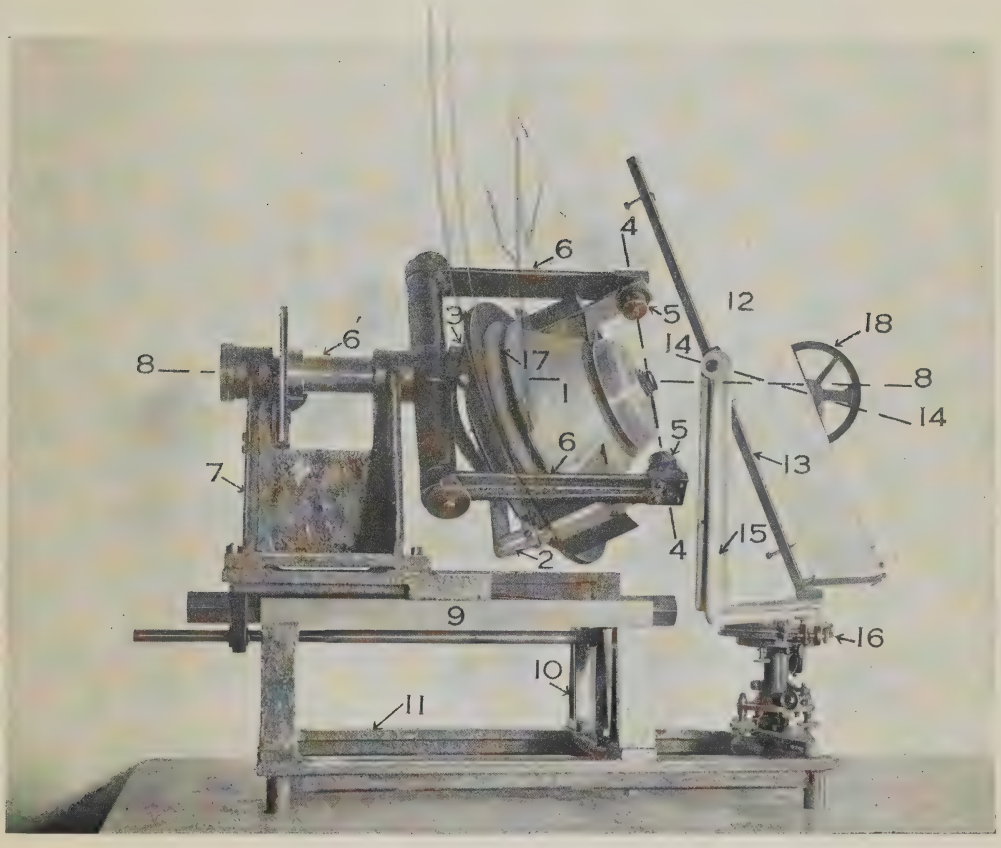


Fig. 4.

the plate was exposed from the air. Angles of rotation of the screen about the axis 14-14 are indicated on the vertical circle 18, angles of rotation to the screen about the vertical axis are shown on the horizontal circle of the theodolite base, and distances of the forward principal point of the projection lens from the screen centre are shown on a linear scale attached to one of the horizontal bars 9, co-operating with a pointer attached to the sliding casting 7. Details of construction of this apparatus are not of importance for the purpose of this report.

The method of operation of the projection apparatus shown in figures 3 and 4 will now be considered. The screen 12 is of plate glass with a translucent coating on the side adjacent to the projection camera. Let figure 5 represent

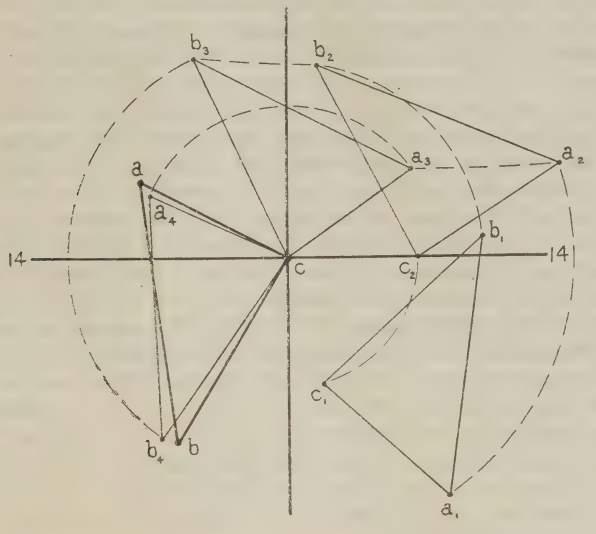


FIG 5

the screen as viewed from the right in figure 3, 14-14 is the horizontal screen axis and c is the screen centre. Control triangles corresponding to the configuration ABC in the plane R_1S_1 (Fig. 1) are plotted on the screen in the following manner. The triangle *ABC* in nature will, in general, consist of three points at different elevations. If the high point be joined to the low point by a straight line there will be a point on this line at the same elevation as the point of intermediate height. The line joining the intermediate point to the position of corresponding elevation on the opposite side of the triangle will be termed the horizontal axis of the triangle. The control triangle is plotted on the screen 12 to the same approximate scale as the projected photograph with the horizontal axis of the triangle coinciding with the axis 14-14, and with the point C of intermediate height at the screen centre c. This control triangle is indicated as abc in figure 5. Suppose now that when the image of the photographic plate is first cast on the screen the control triangle occupies some such position as $a_1b_1c_1$. The coincidence between the projected and the plotted triangles is effected as follows. By rotation of the plate holder of the projection camera the points of the projected triangle $a_1b_1c_1$ will describe on the screen paths circular about c as centre so that the projected triangle moves to the position $a_2b_2c_2$, the point c_2 being brought into coincidence with the horizontal screen axis 14-14 engraved on the screen 12. The projection camera is then rotated about the axis 4-4, which at this stage of the operation is vertical, and the projected intermediate

point is made to shift from the position c_2 to the screen centre c, the other two points of the projected triangle moving along hyperbolic paths from b_2 to b_3 and a_2 to a_3. The rotational adjustment of the apparatus about the axis 4-4 and the angular adjustment of the plate holder 17 is now complete and is not disturbed during the subsequent adjustments which do not affect the coincidence of the projected image of the intermediate point C with the screen centre c. The fork casting 6 is now rotated about the horizontal axis 8-8 and the projected control triangle is made to rotate on the screen about the screen centre c, so as to be brought into approximately the same angular position as the plotted triangle abc. The screen 12 is now rotated about its two axes, which intersect at c, so as to bring its plane roughly into a position normal to the axis of the camera, a typical position after this adjustment being shown in figure 4. The base casting 7 is now slid along the horizontal bars 9 so as to bring the projected image on the screen into satisfactory focus. The apparatus is now in approximate adjustment for coincidence between projected and plotted triangles, as shown by a_4b_4c. Subsequent complete and accurate coincidence between the projected and plotted triangles is secured by sliding the casting 7 on the horizontal bar 9, by rotating the fork casting 6 about the horizontal axis 8-8 and by rotating the screen about its two axes. In practice, it is found that the correct combination of these four adjustments may be effected with rapidity and accuracy. When coincidence between projected and plotted triangles has been effected in this way, the angular relation between the plane of the plate holder and the plane of the screen corresponds to the angular relation between the plate G_1 and the plane R_1S_1 (Fig. 1). If now the screen be rotated about the horizontal screen axis 8-8 through an angle corresponding to the dihedral angle between the plane R_1S_1 and R_1R_3 (Fig. 1), the projection on the screen surface will now correspond with the projection $A_1'B_1'C_1'$ on the datum plane R_1R_3 so that the projection is now horizontal or rectified. Without disturbing the adjustments of the apparatus, a photographic plate is now substituted for the screen 12 and exposed, so as to yield a rectified positive of the plate G_1.

A rectified positive of the plate G_2 is obtained by procedure analogous to that employed with the plate G_1.

Without going into the mathematical theory of the apparatus, consideration will show that when the above described adjustments have been effected the distance of the outer principal point of the projection lens from the screen centre c corresponds to the distance P_1C_1 (Fig. 1) to the scale of the plotted triangle, and that the two circular and one linear scale readings on the apparatus give directly the polar co-ordinates of P_1, the aeroplane position, referred to an origin at C and an axis corresponding to the horizontal axis of the triangle ABC in nature. The rectangular co-ordinates of P_1 are then obtained by the usual conversion formulae. The required constants of the control triangle ABC in nature are calculated by the ordinary methods of solid geometry.

When the two overlapping photographs such as G_1 G_2 have been treated in this way, the configuration corresponding to $P_1'P_2'A_1'A_2'$, etc., shown on the plane R_1R_3 (Fig. 1) are plotted on a surface on which the map is to be drawn. In practice this surface consists of a heavy sheet of plate glass arranged horizontally, with the upper surface, on which the map is to be drawn, covered with a translucent coating. The images of the rectified photographs are then projected on this translucent surface from below, the projection centres being arranged to correspond to image positions of P_1 and P_2. The relative position of the projected images is adjusted to correspond with the configuration shown in the plane R_1R_3. The apparatus is so arranged that the heavy plate glass mapping surface may be shifted towards and away from the projection centres by motions parallel to P_1P_1' and P_2P_2'. It will be seen upon consideration that by this shifting of the mapping surface the two projected images of every

object lying on any particular contour level may be brought into coincidence. It follows, therefore, that contours may be drawn with speed and certainty by arranging that two projections are alternately cast upon the mapping surface in rapid succession, and drawing the contour line through all objects whose images remain stationary without flicker. Other contours may be drawn by shifting the mapping surface to another level and repeating the process. The heights of these contours may be determined in a perfectly obvious manner.

At the time of writing this report the working out of photographs is rapidly nearing completion, but it is not possible at this time to state what will be the accuracy of the finished map. However, from consideration of the accuracy with which the apparatus has been constructed and the clearness of the photographs, it seems probable that the errors will be smaller than the average draughtsman can plot on a map drawn to the same scale as the photograph, vix: 1:20,000, or roughly, 3″ to the mile. But this statement should be accepted with reservation until the map is completed.

In conclusion, the writer wishes to express his very keen appreciation of the efficient and whole-hearted co-operation of the Canadian Air Board and Survey Departments and of Dr. Deville's personal support of the work. Since the experiment started every assistance asked for has been given promptly, the best machines and pilots placed at the disposal of the writer and, in addition, he has experienced the great encouragement of realizing that the work was being supported with enthusiasm. The surveying of the control points, carried out under Mr. H. F. Lambart, was accomplished in mid-winter under very trying weather conditions, with an accuracy well within requirements. It seems at the present time that the success of the experiments is certain, and this success will have depended to a very large extent on the hearty support which the work has had at Ottawa.

APPENDIX No. 2

REPORT ON THE USE OF AIRCRAFT IN FOREST PROTECTION

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Aircraft are used in forestry work in two main ways:—

I. In fire protection.
II. In forest survey and reconnaissance.

1. Fire Protection

Fire protection is developing into a scientific profession requiring detailed study and specialization. Modern methods separate the work into two main divisions:—

(A) Detection.
(B) Control.

(A) Detection is the function of locating fires with the maximum accuracy and the minimum elapsed time from the start thereof. Two methods are possible:

1. Stationary lookouts linked up by telephone. This presupposes the presence of suitable prominent points, ridges or peaks satisfactorily located, and the installation of an elaborate telephone system over the area.

2. Aeroplane Patrols.

(B) Control is the suppression of fire outbreaks. The difficulty of control varies directly to the size the fire has attained, which means also to the elapsed time from the start of the fire until the fire crew has surrounded it and cut off further progress. The objectives of the control organization are, first, reduction to the minimum of the elapsed time between report of the fire by the detection organization and the arrival on the fire lines of an adequate crew properly equipped; second, suppression of the fire with the minimum expenditure of time and money, and the minimum timber or property loss.

Aeroplanes are of very great value in fire protection, primarily in detection, but under certain conditions also of paramount importance in control.

In level country where it is not possible to instal a lookout system, adequate detection can be secured only by the use of aircraft. Under these conditions, therefore, use of aircraft is fundamental to efficient fire protection. In mountain country they have one great value over the lookout system, namely, the ability to function during the peak of a bad fire season when the lookouts are blinded by prevailing smoke pall. The aeroplane observer looks vertically downwards through not more than a mile of smoke, and is not precluded from discovery of fires. The angle of vision of the lookout man, on the other hand, verges on the horizontal so that the smoke has a maximum effect in hindering observation.

Aircraft are of value in control operations in two ways.

(1) For reconnaissance of fire burning by fire foreman. The man in charge of fire-fighting must first form a comprehensive and co-ordinated scheme of attack. Under ordinary conditions, this means circuit of the fire on foot with

resultant delay. In difficult or heavily timbered country real knowledge of conditions is hard to obtain. By using aircraft the fire foreman can quickly and accurately size up the whole situation and develop his plan of attack.

(2) For transport of the fire-fighters, supplies, mechanical equipment, or fire foreman to strategic points. Such transportation implies proper landing facilities. This fact eliminates land machines, for water surfaces are Nature's only natural landing grounds. Mountain regions are generally deficient in water surfaces of sufficient size and number, and air transport is practically impossible therein.

The Laurentian areas of northern Manitoba and Saskatchewan provide optimum conditions for the use of aircraft, and it is in these regions that their greatest value in fire protection can be secured. To begin with these areas abound in lakes, up to 33 per cent of the total area being water. Sea-planes or flying boats may therefore be used. No lookout facilities exist, and use of aircraft on detection work is, therefore, essential to success in fire protection. Means of communication and transportation are largely lacking. The only method of getting men on the fire within a reasonable time after it has been reported is by air transport.

II. Forest Surveying and Reconnaissance

Forest surveys involve the proper definition on accurate base maps of forest types, location of timber bodies, areas of young growth or "burns", together with statements of the amount of merchantable timber on the area surveyed. Experiments have demonstrated the strong possibility of carrying on forest surveys in non-mountainous regions more economically and more accurately from the air than can be done on the ground. Certainly, much more valuable and comprehensive survey of general forest conditions can be made from the air than can be obtained with the same expenditure of money on ground work. Particularly valuable is the possibility of accurately locating areas of young growth of valuable species, on which the future forest industries of Canada depend.

Experience to-day indicates also that detailed cruising may be done from the air. Further experiments along this line are advisable at the earliest possible time.

The detail by the Air Board of aircraft for co-operative work with the Forestry Branch was first effected in the fall of 1920. In September of that year a base was established at Morley, Alberta, for fire patrol purposes. 5,300 miles of air patrols were made that fall, and considerable photographic work was also undertaken. In November of the same year, experimental flights were carried out in the interior of British Columbia, flying boats being used in this instance. Although the lateness of the season gave rise to adverse weather conditions, some 1,700 miles of flying was carried out. These operations proved the suitability of flying boats to fire protection and reconnaissance work in the interior of British Columbia.

Operations on a much larger scale were conducted in 1921. In Alberta the base was moved from Morley to High river. Fire detection by the use of aeroplanes was planned for the entire east slope of the Rocky mountains from the International Boundary north to the James river, a distance of 200 miles. Fire patrols were made over this entire country practically every day of the fire season with very satisfactory results. Installation of wireless on the machines greatly increased the efficiency of the work. In all, some 53,600 miles were covered by the air patrol on fire detection work in Alberta during 1921.

Deficiency of equipment and funds precluded the undertaking of the full programme of air work proposed for British Columbia. Nevertheless some

6,000 miles of flying was carried out for the Forestry Branch, including fire patrol, examination of fires burning, photography, etc. Very excellent results were secured, even under the adverse conditions of working without an organized base, which could not be provided for lack of funds.

A flying boat base was established in 1921 on lake Winnipeg in Manitoba, primarily for fire protection. While the 1921 season was extremely wet and few fires occurred, the flying boats throughly demonstrated their value. The Forest Inspector for Manitoba was so fully convinced of their practicability and superiority to the canoe system or patrols that he dispensed with the services of six fire rangers and considered that he still had better protection than in former years. Over 11,000 miles flying on fire patrol work was carried out in Manitoba in 1921.

In general, the results of the 1921 operations were so successful that plans were perfected for even greater dependence on aircraft in 1922. These plans were subjected to modification by the curtailment of the funds allotted to the Air Board for 1922 operations. Nevertheless the essential requirements of the Forestry Branch were met, and even better results were secured than in 1921.

In Alberta the patrols were systematized and extended, sub-bases and refuelling stations laid down, and the whole operation brought to a higher state of efficiency. Aircraft assumed the entire function of detection for the greater part of the Rocky Mountain area, and performed this work in a most satisfactory manner. During 1922, 72,500 miles of flying was done in Alberta for this service.

In Manitoba, during the season 1922, flying boat patrols and transportation of fire-fighters replaced the former canoe system to a very considerable extent, and resulted in an appreciable saving to the Forestry Branch. Unfortunate loss of equipment by fire and storm detracted from the efficiency of the operations. The work performed was, however, on the whole successful, and the experience gained, particularly with respect to better co-ordination and equipment facilities necessary, gives promise of extremely satisfactory future development in the replacement of the Branch's former fire-fighting organization by using aircraft. Nearly 20,000 miles of air patrol were carried out in Manitoba during 1922.

The essential justification of the use of aircraft in forestry work lies not in any possible economy which may be effected, but in securing a greater degree of efficiency than can be obtained in any other manner. In fire protection nothing short of an organization adequate for all emergencies is worth while as a permanent proposition. The reason for this is that inefficient fire protection is no fire protection at all when it is most needed. A properly functioning organization is therefore not an ideal but a necessity. Adequate fire protection has not come anywhere in Canada yet. The reason is that the necessary organization is highly complicated and technical and can only be secured by steady building year by year on firm and sure foundations. The forest industry is Canada's second greatest industry, and is therefore one on which the future prosperity of our people to a great extent depends. Any method, therefore, within the economic means of this country, which can be utilized to conserve our forest resources from destruction, should and must be adopted.

Under the conditions existing in the great northern forest which forms the northern parts of the Prairie Provinces, the use of aircraft seems to offer the only possible and practicable solution of the problem of fire protection. These forest areas are, in general, uninhabited, isolated from settlement, inaccessible, and at the same time subject to dangerous fire hazard. Distances to be traversed are enormous, no lookout system is possible of development, and in addition no labour supply is available for fire-fighting.

Patrols in the fire-ranging districts in this northern forest country have heretofore been carried out entirely with canoes by a ranger and assistant patrolling over certain waterways, which in some instances are from 200 to 300 miles long. It is, of course, impossible to obtain a view of any distance from a canoe. The result is that fires may be burning within a few miles of a passing patrol. Experience has shown that fires generally reach very large dimensions before they are observed, and at this stage are almost impossible to extinguish. In addition, it is very difficult to supervise a fire-ranging staff organized on this basis. The District Inspector for Manitoba estimates that under the canoe system of patrol 75 per cent of the fires are either not observed or not reported, eventually burning themselves out, or being extinguished by rain, but in the majority of cases doing extensive damage first.

At the very best, under such a system of patrol the fire ranger can be only a moral agent for law and order amongst the north land travellers. With the best will in the world, in a bad fire season, he could not be expected to protect adequately the enormous territory under his charge.

The psychological effect of flying boat patrols in the north country undoubtedly far excels that of fire rangers in canoes. In addition, the use of aircraft provides proper detection by giving uninterrupted observation and possibility of control, by transporting men and equipment to a fire quickly, thus enabling action to extinguish while the fire is still small.

The northern forest country, by reason of the immense distances, lack of labour supply, inaccessibility, etc., as noted above, could be given proper protection with a ground force only by the expenditure of enormous amounts of money. In this country, at least, the use of aircraft can be considered not only as the only efficient, but in fact the most economical means of forest protection. This is the basis for the statement made above, namely, that these northern areas of Laurentian country " provide optimum conditions for the use of aircraft. and it is in these regions that their greatest value in fire protection can be secured." It is of the highest importance, then, that air operations should not only be continued in northern Manitoba but should be extended to cover northern Saskatchewan at the earliest opportunity. Eventually northern Alberta, or at any rate, parts thereof should also be added.

In the mountain country aeroplanes can be used in fire protection only for detection and for reconnaissance of fires burning. At the time when aeroplanes were first tested in Alberta, not a single lookout station was established, the reason being that methods of communicatioin and transportation were just being completed to the stage where use could be made of lookout reports. In other words, the control organization was only then being provided with facilities and equipment necessary for getting quick action on suppression of fires reported. The use of aeroplanes developed just at the stage when our organization in Alberta was faced with the necessity of making heavy capital expenditures on the installation of an elaborate lookout system, involving not only large construction projects but additional personnel obligations and consequent permanently increased overhead costs.

As it turned out, the operation of aircraft in fire protection work proved so satisfactory and so well qualified in every way to meet the needs of the Alberta forests that the lookout system was abandoned. The present situation in Alberta is, therefore, that either aeroplane operations must be continued, or a lookout system must be installed. Even if discontinuance of the operation of aircraft is projected in Alberta, air patrols are essential for a few years pending the transition to a lookout system. From its standpoint the Forestry Branch is not in favour of giving up aircraft in Alberta for a lookout system. Other incidental benefits accrue from the air operations, which are in themselves of

great importance. These are, first, publicity and awakening of public sentiment in favour of forest protection, and, second, use of aeroplanes in forest reconnaissance and exploration in the mountain country.

Conditions in the Railway Belt of British Columbia are different. Here, in the interior particularly, the presence of extensive Dominion Government rural telephones has led to the construction of a complete lookout system. Hence aircraft are needed in fire protection only for a short time during the peak of the fire season to supplement existing facilities. Excepting on the Coast where week-end patrols are valuable for their psychological effect on Sunday fishermen from the towns and cities, the aeroplanes' principal use will be in reconnaissance of fires burning, and in emergency transportation of fire foremen or mechanical equipment. A large field, however, awaits the Air Board in British Columbia, as in the other provinces, in the development of aerial photographic forest surveying.

The Forestry Branch has not, to date, undertaken co-operative work with the Air Board in Eastern Canada. Much flying has, however, been carried out by the Air Board for Provincial Governments, and the results secured have been made available to the Branch. Particularly valuable in its possibility for future use, has been the data secured on aerial forest surveying and technical development in photography in connectioin therewith. The practical utility of this work has been so thoroughly proved that it is planned to use this means in 1923 for carrying on work in Eastern Canada to which the Forestry Branch is already committed. Of first importance in this connection is the compilation of estimates on the forest resources of Ontario, part of a national undertaking, of estimating the forest resources of all Canada, province by province. Northern Ontario is as suitable for aircraft operations as northern Manitoba or Saskatchewan. The inaccessibility of this region and its large extent indicate that the general reconnaissance necessary for the forest resources work can be most economically and most efficiently conducted from the air.

Besides this general work, this service is making a special study of pine reproduction in central Ontario. Aerial photographic surveying is the most logical method of undertaking this work, because in this way results can be obtained in one season, which by old ground methods would take years to complete. Another special study with tremendous possibilities is the proposed conduct of experimental work and research in making detailed timber estimates by aerial photography. If the results anticipated can be proven as possible of attainment, and applicable on a general basis, no one feature of research work will be more worth while. These last two special studies are planned to be undertaken by the use of Air Board equipment detailed to the Ontario Government for fire patrol work in central Ontario.

To summarize, the continuance of air work in forest protection is justified in the northern forest region of the Prairie Provinces, because:—

(1) It is the only possible method of obtaining adequate fire protection;

(2) It is the most economical means of attaining this end.

It is justified in the mountains of Alberta because:—

(1) It has obviated the necessity of making a large capital expenditure in the installation of a lookout system;

(2) It has replaced the lookout system satisfactorily in every way;

(3) It has brought incidental advantages in publicity and awakening of public sentiment for forest protection in Alberta in a way which no other method could duplicate.

The extension of air work into Eastern Canada is justified because:—

(1) It provides the most economical and efficient method of carrying on the forest resources survey of Ontario, to which this service is committed;

(2) It provides unique facilities for the conduct of reproduction studies in central Ontario;

(3) Experimental work and research in detail timber estimating by aerial photography gives promise of producing results of unsurpassed importance in the conduct of forest administration over all Canada.

Following is a tabular statement of the number of miles flown on forestry work during the seasons 1920 to 1922 inclusive:—

Province	Year		
	1920	1921	1922
	Miles	Miles	Miles
Manitoba	–	11,000	20,000
Alberta	5,300	53,600	72,500
British Columbia	1,700	6,000	–
Totals	6,000	70,600	92,500
Percentage of total flying done by Air Board	.....	40	46